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A STUDY OF THE PUBLIC WATER SUPPLIES OF Ohio is to be made by the Board of Health of that state. The Board now passes upon all plans for new water-works and sewerage systems and important improvements to old plants, under an act passed in 1893, having passed on 40 water supplies and 33 sewerage systems since that time. To aid it in this work the Board has inaugurated a careful study of various lakes and streams of the state, both as to quality and available quantity. Mr. Allen Hazen, St. Paul Building, New York city, is Consulting Engineer for this work, and three professors in the Ohio State University will, it is expected, take a part in it, Prof. C. N. Brown making stream gagings, Prof. N. W. Lord, chemical analyses, and Prof. A. M. Bleile, bacterial examinations. A report on the underground waters of Ohio will be made by Prof. Edw. Orton, State Geologist. Maps will be prepared to illustrate the reports on the investigations.

THE VALUE OF THE WATER-WORKS OF NYACK, N. Y., has been fixed at $107,750 by the commissioners of appraisal, appointed to determine what price the village should pay for the property of the Nyack Water-Works Co. The findings of the commission are of unusual interest, owing to the fact that the value of the real property and of the "franchise and good will" are given separately, the latter being appraised at $25,000. The appraisers were Messrs. Wm. McCanley, Jr., Jno. M. Verdin and Louis J. Lediger. The experts for the company were Messrs. Jos. B. Rider, W. L. Whittemore and Jno. Bogart, Messrs. Jas. S. Haring and L. L. Tribus appearing for the city. We are indebted to Mr. Haring for the above information.

THE DAMMING OF THE RIO GRANDE RIVER, by an English corporation for irrigation purposes, is objected to by the Mexican government, in a communication to the State Department of the United States, as seriously interfering with navigation. The proposed dam was to be located on the American side at Elephant Butts, New Mexico, and authority for its construction was granted by the Secretary of the Interior under the Desert Land laws. Attorney-General McKenna has now decided that the construction of the dam would injure persons along the Mexican side of the river, and would therefore be a violation of international law. He has consequently instituted civil and criminal proceedings to stop the work. The projected international dam at El Paso would also become useless if the Elephant Butts dam were erected, according to a report made to the War Department by Col. Anson Mills, U. S. A., and International Boundary Commissioner.

A SIMPLE DEVICE FOR REMOVING WEEDS FROM an irrigation ditch has been used at North Loup, Neb. Two oak timbers, each 6 ins. square and 14 ft. long, were connected at one end by a heavy chain about 2 ft. long, between timbers. A mowing machine wheel was attached, to the chain as a weight. The timbers were extended up opposite banks of the canal and with a span of horses attached to each timber, and a man to each span, rapid progress was made in breaking down the weeds. Later the weeds and grass were burned. We are indebted to Mr. Samuel McClellan, the inventor of the device, for this information. Before using the machine the weeds were broken down by hand.

THE PASSAIC VALLEY SEWERAGE QUESTION made but little if any progress during the recent session of the New Jersey Legislature. The report of the commission appointed a year ago to investigate the subject, which report was abstracted and editorially discussed in our issue of March 11, 1897, included a bill submitted for passage by the legislature, which provided for the early construction of intercepting sewers, discharging by the aid of pumps into Newark Bay. Instead of passing such a bill, the whole matter was referred to a legislative commission for consideration, and for report to the next session of the legislature. The commission consists of State Senators Robt. Williams, of Paterson, and Wm. M. Johnson, and of Assemblymen Theo. C. Wildman, of Arlington, N. J., and Louis T. Deroussee.

A PLAN FOR IMPROVING THE SANITARY CONDITION of the Neponset Meadows, near Boston, has been submitted to the Massachusetts legislature by the Board of Health of that state. The meadows have an area of about eleven square miles and are situated some 10 to 13 miles from the State House, in Boston. They are uninhabited, to a large extent uncultivated, and through flooding, decaying vegetation and the pollution of the river are declared to be a nuisance which should be abated. The Board recommends the straightening and enlargement of the river channel at points; the permanent removal of flash boards at a dam on the stream; and additional legislation to prevent the entrance into the stream of sewage and manufacturing wastes which have not been satisfactorily purified. The estimated cost of the improvements, not including land and water damages, is $125,000. The investigation cost about $3,000. Mr. X. H. Goodnough, State House, Boston, Mass., is Engineer of the State Board of Health.

SOME IMPORTANT PUBLIC IMPROVEMENTS IN Philadelphia are likely to be started soon, the courts having decided that the city has not reached its borrowing capacity. Two appropriation ordinance of July and December, 1896, have been inoperative while awaiting this decision. Water supply, including possible filtration, subways, gas works and city buildings, are among the improvements said to be affected by the decision.

THE OPENING, WIDENING AND EXTENSION of Elm St., in New York city, will cost $5,108,847 for damages to property, according to the late report of the commissioners of estimate and assessment of this street, appointed in 1895. The property holders claimed $6,118,570. The commission has yet to determine the area to be assessed for the cost of the improvement.

BIDS FOR THE PURCHASE OR LEASE of the municipal gas plant of Richmond, Va., may be invited soon. The city is one of a dozen in the United States that owns its gas works. Talk of selling the plant to a private company arises from time to time, but has always subsided before definite action has been taken. Recently an offer of $1,000,000 is reported as having been made by an "acetylene gas syndicate," with subsequent offers from other sources. A committee has recommended that the city council call for bids for the purchase or lease of the gas works, the question to be submitted to popular vote, after the bids are received. Quite likely the matter will be dropped before proceeding much further, but if not, the results of the invitation for bids and of the popular vote will be watched with interest.

MUNICIPAL OWNERSHIP OF LIGHTING PLANTS AT St. Louis is favorably considered by the Board of Public Improvements, which has just sent to the city council an ordinance calling for bids for: (1) lighting the streets by electricity and (2) by gas for 20 years, from Jan. 1, 1900; also for building and leasing to the city for 30 years (3) an electric and (4) a gas-lighting plant, the city to have the right to buy either plant at the expiration of the lease. Out of the various proposals invited it is hoped that the city will be able either to secure a plant under its own control, or a very favorable price for street lighting from some private company. The ordinance has been read once in the city council, but it is said that it is likely to meet with serious opposition in its present form, from the gas and electric interests of the city.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was caused by the collapse of the bridge carrying the Atchison, Topeka & Santa Fe Ry. over the Arkansas River, at Lamar, Colo., May 8. A westbound passenger train was crossing the bridge, and the engine and four cars went down, leaving the two sleeping cars on the track. Three persons were injured. The foundation of the bridge had been undermined by floods.

A TERRIBLE FIRE occurred at Paris, France, May 4, by which about 120 to 150 persons were killed. A bazaar for charitable purposes was being held in a temporary structure filled with booths built to represent a street of old Paris, and the structure and decorations were of very inflammable material. While the place was crowded in the afternoon fire broke out and in a few minutes the whole place was in a blaze, the burning roof and decorations dropping down upon the crowd and setting fire to the people's clothing. In the rush for the only exit numbers of persons were thrown down and trampled upon, the exits were blocked by the crowd and those inside were at the mercy of the flames.

A LOCOMOTIVE BOILER EXPLOSION occurred May 4 at Kansas City, Mo. A freight train of the Chicago & Alton R. R. was standing at the Oak St. freight station when the latter exploded, killing the engineman and fireman.

THE DRAWBRIDGE ON THE MAIN LINE OF THE Pennsylvania R. R., over the Passaic River, at Newark, N. J., was damaged on May 5 by the derrick on a wrecking train, which was crossing the bridge at the time. It appears that the top of the derrick was too high to clear the top bracing of the bridge truss, and it tore some of the braces away and disarranged the machinery of the draw-span, so that the draw could not be opened.

THE NEW BROOKLYN TIMBER DRY DOCK, on May 8, commenced to leak seriously on the east slope, on a line 4 to 18 ft. above the floor, and the leak has since developed on the west side on the same line. The battle-ship "Massachusetts" was in the dock at the time, and the opinions of the officials differ as to the cause of the leakage. The sea-wall to the east of the dock is still incomplete, showing a gap of 190 ft., and it is supposed that water may enter from that direction. But the most plausible theory is one connected with the known fact that the site of the dock was once cut by lines of timber-cribs, filled with loose stone. The corner of one of these cribs comes within 30 ft. of the new dock, opposite where the first leak occurred. These cribs were removed, or cut off by lines of sheet piling, but it is possible that the piling was interfered with, in some cases, by the crib and loose stone left below the sheet piling, through which water could enter and make its way through the clay backing. The water is supposed to pass from the east to the west side under the 5-ft. concrete floor of the dock, but this floor is believed to be safe against the lifting action of the 35-ft. head of water. Work is being pushed upon the sea-wall, and the dock is to be filled at once and new lines of sheet piling will probably be driven. Since writing the above the official report of an examining board has been forwarded to the Navy Department. This board attributes the leakage to the old filled-in adjacent dock, and regards the leak as being much more serious than was at first supposed. The new dock will be out of service for some time.

THE NORTH GERMAN LLOYD steamer "Kaiser Wilhelm der Grosse" was launched by the Vulcan Steamship Co. at Stettin, on May 4. This ship is one of the largest in the world, being 648 ft. long over all, 66 ft. beam and 43 ft. deep, with a displacement of 20,000 tons and a tonnage of 14,000. She is fitted with bilge keels, and has 18 watertight compartments extending to the upper deck. Accommodations are provided for 350 first class passengers, 370 in the second cabin and 800 in the steerage, with a crew of 450 men. A sister ship, the "Kaiser Friedrich," will be launched at the yards of F. Schichau, at Dantzic, some time next month.

THE MIDFORD PNEUMATIC SALVAGE CO., of 45 Broadway, New York, is in the hands of the Sheriff. This company was incorporated in 1896, with a capital of $300,000, for the purpose of raising sunken vessels by a new system of caissons, filled with water or air at the will of the operators. These caissons were shaped like great wooden casks, and one feature of the device was the facility with which the casks could be unhooped, and hoops and staves packed for ready transportation. The first test of the appliance was made on the hull of the steamer "Ailsa," sunk near Fort Hamilton, in the Narrows, and about $50,000 was expended by the stockholders with no satisfactory result. The unfortunate outcome of the enterprise is said to have been due to exceedingly inefficient management and not to any radical defect in the scheme itself.

THE LIGHT DRAFT GUNBOAT "NASHVILLE" is about to undergo her official trial trip off New London, in Long Island Sound. The "Nashville" was ordered by Congress in March, 1893, along with the gunboats "Wilmington" and "Helena," and the three were contracted for by the Newport News Shipbuilding & Dry Dock Company. The two latter boats have military masts, but the "Nashville" is a two-masted schooner, 220 ft. long, 38 ft. 3 in. beam, 11 ft. mean draft and 1,371 tons displacement. She has twin-screw, vertical quadruple expansion engines of 1,750 I.HP., and is designed for a speed of 14 knots. Her armament is eight 4-in. rapid-fire guns, four 6-pdr. and two 1-pdr. rapid-fire guns and two gatlings. She will have a crew of 158 men, with 11 officers, and the contract price for hull and machinery was $280,000, the same price being bid for the sister boats. Within the next few weeks seven of the composite gunboats ordered by Congress will be in commission. These include, besides the boats mentioned above, the "Annapolis," "Newport News," "Marrietta" and "Vicksburg."

EFFECTS OF MISSISSIPPI RIVER FLOODS ON THE NEW ST. ANTHONY FALLS DAM AT MINNEAPOLIS.

By Horace B. Hudson.

The failure of the new dam at Minneapolis on March 31 has been quite generally referred to in press reports as a disaster of considerable magnitude. Exaggeration has been common and accuracy impossible in these statements; for it is only quite recently that the water has fallen sufficiently to allow even an approximate estimate of the injury to the dam. The conditions under which the break occurred were so unusual as to make the facts, exactly stated, of special interest.

In 1895 the Pillsbury-Washburn Flour Mills Co. of Minneapolis commenced the construction of a dam for the purpose of utilizing the fall of about 20 ft. in the rapids of the Mississippi River immediately below the Falls of St. Anthony. The work was designed and carried out by Mr. Wm. de la Barre, M. Am. Soc. C. E., the engineer who has for many years had charge of the extensive improvements of the St. Anthony Falls water power. During the past winter the 10,000 HP. to be generated at the dam was leased for a long term of years to the Twin City Rapid Transit Co., and that corporation being desirous of an early use of the power the work of completing the dam was prosecuted during the remaining winter months. The section of the dam thus built was about 366 ft. in length and extended directly across the main channel of the river. At Minneapolis the spring floods seldom arrive earlier than the middle of April, and when the last masonry was laid, on March 24, 1897, it was reasonably expected that there would be two or three weeks in which supplementary work might be done, rock filling put in, and aprons constructed.

But on the very day when the last rock was laid, information was received that the river was rising rapidly above as the result of the sudden melting of an unusually heavy snowfall and within 2½ days water was flowing over the crest of the dam. It was therefore impossible to do any adequate supplementary work, and it was only by the most strenuous endeavors and the workings of a large crew night and day that the extensive construction plant was removed from the bed of the river in time to prevent its destruction. The dam thus went into the flood with most of its masonry green and without the intended protective apron for preventing the direct hammering of the ice and logs which might come down with the floods.

Under ordinary conditions the ice is much softened before breaking up in this vicinity, but the sudden thaw found the ice thick and hard. On March 31 an enormous gorge which had formed about 20 miles above the city, broke and swept the river clean for the entire distance to the falls. In its course this gorge carried away about 28,000,000 ft. of logs, an immense number of booms, hundreds of piles set in the channel of the river, as well as many massive boom piers constructed in cribwork and heavily weighted with stone. These piers are about 16 × 24 ft. in size and put together so solidly that one of them went over the falls intact and striking the dam carried away a section of the steel coping. After this first break the disintegration of a large section of the green masonry followed, caused partly by the water pressure and partly by the continuous impact of the ice and logs for several days. At the height of the flood the flowage was over 60,000 cu. ft. per sec.; the largest discharge of water during the past 30 years. So tremendous was the force of the water that granite blocks from the dam weighing 7,000 lbs. were carried a long distance down the stream, some of them having been found fully 1,800 ft. from the works.

At the present time the water has fallen so far that the damage is seen to consist of the loss of the three top courses of granite for a distance of about 110 ft. about in the middle of the dam, and of the coping, and perhaps a single course of stone, for the remaining 140 ft. to the eastern end. For a distance of about 100 ft. from the western end the dam was uninjured.

The repair of the injury will be a comparatively simple matter and will involve no delay in the operation of the power plant now being installed. As soon as the river falls sufficiently a coffer dam will be constructed above the break and the masonry can then be replaced at leisure, as summer freshets are unknown here. The entire loss occasioned by the break will not exceed $6,000.

The accompanying illustrations convey a good idea of the appearance of the dam when the water commenced to flow over the coping in large volume and of the dam as it now appears, showing a large volume of water passing through the break.

FIG. 1.—VIEW TAKEN AT 11 A. M., MARCH 31.

FIG. 2.—VIEW TAKEN AT 10 A. M., APRIL 1.

FIGS. 1 AND 2.—VIEWS OF NEW DAM ACROSS THE MISSISSIPPI RIVER AT ST. ANTHONY FALLS, MINNEAPOLIS, MINN., SHOWING EFFECT OF FRESHET.

THE OFFICIAL TRIAL TRIP OF THE U. S. GUNBOAT "ANNAPOLIS."

The new gunboat "Annapolis," which is the first to be completed of the six composite hull boats ordered by the government early in 1896, was given its official trial of four hours at full speed on Long Island Sound on April 22. This gunboat is notable as being the first U. S. government vessel of large size to be fitted with boilers of the water tube type exclusively. Other vessels have been built within a few years in which the Scotch type and

FIG. 3.—VIEW OF ST. ANTHONY FALLS DAM ON MAY 5, 1897, AFTER FRESHET HAD PARTIALLY SUBSIDED.

the water tube boilers have both been used in connection with each other.

The "Annapolis" was built at the Crescent Ship Yard, Louis Nixon, Manager, Elizabethport, N. J., and the boilers were furnished by the Babcock & Wilcox Co. of New York city, whose works are also at Elizabethport. The same type of boiler has also been adopted for the gunboat "Marietta." The general form of the Babcock & Wilcox marine boiler was illustrated in our issue of March 25, in connection with the description of the Plant Steamship Co.'s new steamer, "La Grande Duchesse." In this boiler the water tubes are all straight, placed at an angle of 15° with the horizontal, and expanded at each end into forged steel headers. Openings are provided in these headers opposite the ends of the tubes, through which a thorough examination of each tube may be made, and the tubes cleaned and renewed when necessary. By means of a steam jet inserted between the headers all deposits of soot may be removed from the exterior of the tubes. Surmounting the sections of tubes is a steam and water drum 42 ins. diameter and 10 ft. long; all openings leading into and out of drum are 4 ins. diameter. Steam to 200 lbs. pressure can be raised from cold water in half an hour, this being a most important feature in boilers for a warship. The boilers are designed for a working pressure of 250 lbs.

The principal dimensions of the "Annapolis" and of its steam equipment are as follows:

Length, 204 ft. Width, 36 ft. Depth, 23 ft. 3½ ins. Displacement on a draft of 12 ft., 1,000 tons. Boilers, two, each 94 sq. ft. of grate and 3,600 sq. ft. of heating surface. Ratio of grate to heating surface, 1 to 38.3. Engine, triple expansion, with cylinders 15, 24½ and 40 ins. diameter, 28 ins. stroke. Contract speed of vessel, 12 knots with 800 I. HP. The builder's trial showed that 900 I. HP. could be developed under natural draft, with a short funnel.

On the official trial forced draft in the ash pit was used, each boiler being supplied by air from independent Sturtevant fans, the average air pressure in the ash pit being limited to 1 in. of water.

During the 4-hour trial the steam pressure averaged 226 lbs. per sq. in., the minimum being 218 and the maximum 240 lbs. The draft pressure in the ash pit averaged 0.90 in. on the port side and 0.91 in. on the starboard side. The speed trial over a measured course of 48 knots, marked by nine stake boats, gave a speed in the eight divisions of the course ranging from 12.7 to 14.18 knots per hour, averaging 13.43 knots.

The maximum I. HP. developed by the main engine was 1,400, the average being 1,320, at 147 revolutions per minute. The collective I. HP. will average about 1,360. Dividing 1,320 I. HP. into 3,600 sq. ft. heating surface gives one I. HP. for each 2.73 sq. ft. of heating surface. Dividing it by 94 sq. ft. of grate gives 14 I. HP. per sq. ft. of grate. During the test under forced draft the smokestack did not become hot enough to burn the paint off it.

At the end of the test of four hours at full speed the helm was put hard to port and to starboard without reducing speed, and the little vessel made circles with a diameter of 400 ft. In turning she heeled only 3.5 degrees.

THE NEW PENNSYLVANIA STATE CAPITOL, at Harrisburg, Pa., is to be built upon plans obtained under the following conditions, as fixed by the Capitol Building Commission: Six architects of reputation are to be selected who shall receive from $500 to $1,000 each in payment of expenses incurred in entering into competition. If any one of this six wins the prize, the preliminary expenses are to be deducted from his fees. These six architects will name one of the jury to decide upon the winning plan; Prof. Warren Powers Laird, the architectural advisor of the commission, will name a second member of the jury, and these two will select a third. The grand prize is the position of architect during the construction of the capitol building.

THE GREATER NEW YORK.

The Greater New York will be the second largest city in the world, only London exceeding it in wealth and population. The New York "Times" gives some comparative statistics that are interesting in this connection and are abstracted as follows: Roughly speaking, the new New York will be 32 miles long and from 12 to 18 miles wide, covering an area of about 360 square miles, including water area. It will have a population of 3,312,000, with an aggregate valuation of nearly $4,560,000,000 and a debt of $205,500,000. Included within the limits of the new municipality will be nearly 3,000 miles of streets, 1,150 churches and 351 public schools. The water front amounts to about 300 miles in length, and there are nearly 1,000 miles of railway within the city limits. The five boroughs constituting the Greater New York have the following approximate area, populations, valuations and debts:

	Area, sq. miles.	Population.	Valuation.	Bonded debt.
Manhattan	60	1,825,000	$3,695,000,000	$120,238,317
Bronx		135,000		
Brooklyn	77.51	1,132,554	740,000,000	76,821,000
Queens	123.98	150,000	75,000,000	7,000,000
Richmond	67	70,000	49,600,000	1,500,000
Totals	328.49	3,312,554	$4,559,600,000	$205,559,317

Some idea of the administrative ability demanded in conducting the affairs of the new municipality can be gathered from the following general statement, taking the several boroughs separately: Manhattan and Bronx must be taken together, however, in these statistics, as they form what was once New York proper. This division has 102,000 buildings, 750 miles of streets, 575 miles of sewers, 5,000 acres of parks, a water supply of 300,000,000 gallons daily, 40,000 electric and gas-lights, about 365 miles of surface and elevated railway tracks, a police force numbering 5,004 individuals, a fire department with 1,173 uniformed men, 64 fire engines and 22 hook and ladder outfits.

The Borough of Brooklyn has 1,539 acres of parks, 1,503 miles of paved and unpaved streets, 354 Protestant and 78 Roman Catholic churches, 250.4 miles of surface and elevated railways and a daily water supply of 86,000,000 gallons, distributed by 558 miles of mains.

The Borough of Richmond includes the whole of Staten Island, an island about 7 miles wide by 13 miles long. It has 29 miles of double and 8 miles of single track railway, and the water supply, drawn from artesian wells, is abundant and pure.

The Borough of Queens includes Long Island City, and the towns of Newtown, Flushing, Jamaica and a part of Hempstead, with large manufacturing interests, and a total railway track mileage of 60 miles. The total length of streets in this borough is about 75 miles, with about 195 miles of dirt roads. No accurate estimate can be made of the more detailed statistics of the boroughs of Richmond and Queens.

As compared with the latest available census reports and estimates of the other great cities of the world, the population of the Greater New York will compare as follows:

Cities.	Population.
London	5,600,000
Greater New York	3,312,000
Paris	2,444,000
Chicago	1,750,000
Canton	1,600,000
Berlin	1,579,244
Tokio	1,389,684
Vienna	1,364,548
Philadelphia	1,200,000
St. Petersburg	1,035,439

ELECTRICITY IN MINING.

A paper on "Electric Mining in the Rocky Mountain Region," by Irving Hale, and another on "Additions to the Power Plant of the Standard Consolidated Mining Company," by Robert G. Brown, were read at the Colorado meeting of the American Institute of Mining Engineers. In the discussion which followed these papers some interesting points were brought out in the application of electricity to mining operations.

Mr. Brown, in speaking of the plant of the Standard Company, pointed out several errors of design to be avoided. The first relates to the too common insufficient carrying capacity of the rheostat, or starting resistance used with the hoist. In constant running, with frequent starts and stops, the rheostat carries a great part of the current at times and the heating is so tremendous that at the Bodie mines it is necessary to stop hoisting for a time to allow the rheostat to cool off and prevent warping or cracking of the castings. The failure to establish a suitable air-cushion at the end of the pipe line also gave trouble. A quick throb can be felt in this pipe, caused by throwing off the motor in the mines, 12 miles away, which causes the governor to act, partially closes the gate and decreases the velocity of flow in the pipe. This action severely strains the pipe and can be prevented.

Sufficiently accurate data are wanting, says Mr. Brown, for comparing the relative advantages of electricity and compressed air. The Standard Company could not run without the aid of electricity; but, on the other hand, at the North Star Mine they compress air directly by the use of an 18-ft. Pelton wheel, transmit the power a short distance and then employ air reheated to 350° to 400°, and thus obtain a high efficiency at a low expenditure of heat. The simple transmission cost per horse-power would be a controlling consideration in cases of transmission for many miles; but, says Mr. Brown, when it is a question of concentrating the power at one place, or carrying power from water at the foot of a hill to the top of it, a mile or so away, it is by no means a foregone conclusion that electricity does cheaper or more satisfactory work than compressed air.

Lightning arresters were among the important things to be considered, especially in mountainous regions where lightning is always very severe. Mr. Hale described the three kinds in use as follows: One consists of a number of cylinders of non-arcing metal, placed parallel and close together, but with little gaps between over which the lightning jumps. As the metal does not establish an arc, or bridge under the action of the current, the dynamo current does not follow the lightning discharge. In another type of arrester the lightning jumps across a small gap, and a strong magnet is placed with the lines of magnetic force across this gap. The magnetic lines have the effect of "blowing out," or stopping the arc. In a third recent arrester the gaps are between metal discs of sufficient surface to radiate the heat so rapidly as to dissipate the arc. The last arrester is simple, cheap and apparently very efficient. At the Silver Lake Mine, at Silverton, power is transmitted to an altitude of 12,300 ft., or about 3,000 ft. higher than at the Brodie Mines.

As a line protection against lightning, a barbed wire is run along the tops of the poles and grounded every few poles in wet soil, at the Silverton, Telluride and Ouray Mines. It is not certain that this device is of much service; but the general opinion is that it affords sufficient protection to make it worth putting up.

Mr. D. W. Bunton, of Aspen, Colo., in speaking of the electrical hoisting plant at the Free Silver Mine, said that they found an economy of 66% in overbalanced as compared with the direct or unbalanced hoist. At the Della S. Mine, where the wire cable had to be carried over two sheaves and bent twice, the change from direct to an overbalanced hoist resulted in an economy of 50%. By overbalancing is meant the counter-balancing of the weight of the cage and the car and one-half of the live load.

Mr. Julian A. Kebler, of Denver, said that he had recently put in an electric plant in the Rouse Coal Mine, which was originally opened by a slope descending on a grade of 5%. When the mine was first operated the slack, or fine coal was unsalable and the cost of fuel was not considered; but after the steam had been carried 2,000 ft. the use of an air compressor became necessary. More water was encountered, and a second and then a third compressor was installed; but finally, when they were pumping 600 gallons a minute through 4,000 ft. of pipe and up a vertical lift of 100 ft., an electric plant was put in place. Several reasons combined to bring about this later change. The air from the three compressors was being carried through two 4-in. pipes, and the supply pipes were thus too small. Further, the slack was now salable and a more economical pumping plant was demanded. It was a question of either putting in more compressors and larger pipes or of trying electricity. A compound, condensing, high-speed engine was coupled directly to the dynamo, and motors were put in to run not only the pumps but also the fans, screens and the machine shop. In this case, said Mr. Kebler, the use of compressed air under the most adverse circumstances is compared with electricity under very favorable conditions; but the same amount of work is now done

with 5 tons of coal that with compressed air consumed from 35 to 40 tons.

Mr. Hale did not regard as possible any great utilization of wind-power in the generation of electricity. Even with the latest devised machines, which are supposed to maintain a constant voltage at varying speed, he thought that the enormous cost of the wind plant, in proportion to the power developed, and the impossibility of storing any large amount of power, would stand in the way of its adoption.

THE CHASSAGNE PROCESS OF PHOTOGRAPHY IN NATURAL COLORS.

Considerable has been published in the newspapers of late concerning a remarkable new process of color photography, the invention of a Frenchman, M. Villedieu Chassagne, of No. 40 Avenue des Pernes, Paris. We find in the current number of "Consular Reports" an extended description of this process by Mr. Frank H. Mason, U. S. Consul at Frankfort. We quote from it as follows:

An ordinary sensitized gelatin plate is first treated by immersion in a colorless solution of certain salts, the secret of which the inventor has not yet revealed. This plate, being exposed in a camera, receives a negative impression, and is developed, fixed and finished in the ordinary manner, producing a monochromatic negative precisely similar in appearance to any other.

From this negative there is then printed, by the usual process, a positive, which may be made on sensitized paper, or film, or glass gelatin plate, which has been likewise treated before printing with the same colorless and unexplained solution. Thus far, all is monochromatic, and does not differ in appearance from any ordinary negative and the paper print or transparent positive made therefrom. The miracle now appears in the fact that the treatment of the negative plate and positive print with the limpid solution has imparted to the latter the occult instinct of selective absorption; in other words, the power to absorb and assimilate from solutions of the primary colors the exact quantity and proportion of each tint that is required to produce all the hues and gradations of nature.

The positive is now passed successively through three colored solutions—blue, red and green—and from these it takes up by absorption the proportionate amount of each color that is required to give the colors and gradations of tint which were present in the natural subject of the photograph. If this photograph is a portrait, the flesh tints become warm and vital, the colors of the eyes, hair, and every detail of hue in the costume, jewelry, etc., are faithfully reproduced. The process of using these liquids, which is so simple as to be within the easy reach of any professional or good amateur photographer, has been patented in all civilized countries where patents are granted, but the composition of the liquids is thus far a secret, and is not described in the applications.

Having perfected his process to a point where his pictures commanded the admiring wonder of French experts, M. Chassagne went, on Jan. 15, to London, where on two occasions about Jan. 20 he demonstrated it at the laboratory of King's College, in presence of Sir Henry Trueman Wood, Captain Abney, President of the Camera Club; Professor Thompson and Mr. Herbert Jackson, of King's College, all men of the highest authority in photographic science. The demonstrations were so complete, the results, when Sir Henry Wood and Captain Abney operated with English apparatus on plates treated in their presence with the liquids brought by the inventor from Paris, were so successful that the process became the sensation of the day in London, and the whole invention, with its patents granted or pending in all countries, was sold on Jan. 28 for a large sum to a British syndicate that had been hastily organized for its purchase.

Notwithstanding the demonstrations of the success of the process which are said to have been made in King's College in the presence of eminent authorities, the statements are so startling, and so opposed, apparently, to all that has been heretofore known concerning the action of light upon photographic plates that we are strongly inclined to believe that the whole matter is a hoax. Mr. Chassagne's process is in reality the effect produced on the plate by its exposure in the camera, and development is not merely a darkening of the portions exposed to the most light, but some other change in the physical or chemical condition of the surface, which makes the negative after developing and fixing not merely a plate of greater or less transparency in spots, but a plate through which if white light passes in making a print from it, there passes in addition some mysterious and wonderful influence, which causes the print made from the negative to become something more than a mere reversal of the negative as regards the degree of darkness of its various portions, but to become in addition an object which is capable of "the occult instinct of selective absorption," by which it selects from blue, red and green solutions the proportionate amount of each color required to duplicate in the print the colors and gradations originally present in the object photographed.

It must be said also that besides the scientific reasons for doubting the reports as to the merits of this process, the manner in which it is being exploited, as stated in a part of Mr. Mason's report, which we do not reprint, is sufficient to make one cautious in accepting the statements of its promoters. That color photography by other processes, which have already been made known to the scientific world, is likely to be a commercial success, we fully believe, but our faith is too weak to permit us to place much confidence in any process which depends for its success on the transmission of "the instinct of selective absorption" from a photographic negative to the print placed over it.

A NEW WATER TUBE BOILER.

The accompanying engravings illustrate a water tube boiler recently put on the market by Jackson & Church, of Saginaw, Mich., for which especial claims of simplicity and efficiency are made by the builders. The illustrations and following description give the information which has been submitted to us to justify these claims and can be studied by each reader for himself.

As will be seen the boiler has three shells connected by three series or banks of tubes bricked in in the manner shown. All the tubes connecting the end and center shells are of the same length and this is, of course, the case also with the longer tubes connecting the end shells. The end shells have convex outside heads provided with arm holes for cleaning and repairs, while the inner shell is connected with the dome by a large opening that will admit two men if necessary. The dome, of course, has the usual manhole entrance, and the following further description is furnished in a letter from the builders:

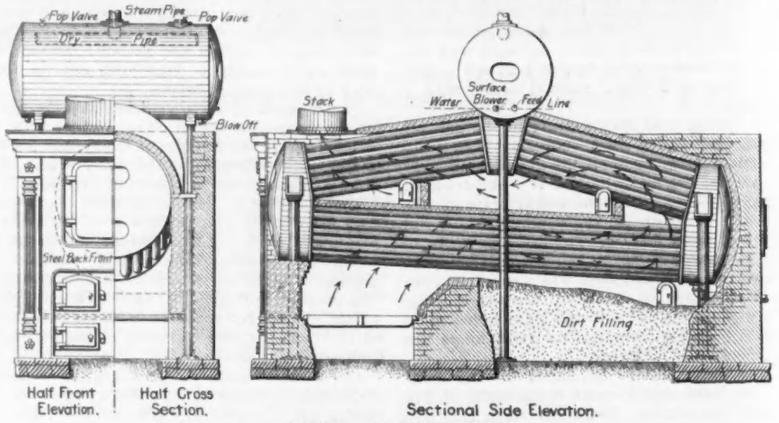
By a glance at the drawing it will be noticed that we have provided two manhole plates for boilers of 100 HP. and below, and four for boilers above 100 HP. These manholes are for removing the tubes and for getting inside of the shell to examine the flues and to clean and make repairs. The dome is flanged to the center shell, leaving the center of the dome about 4 ins. higher than the ends. The feed water is put into the dome at one end on the water line, the pipe carrying the water running around the dome to near the starting point, where it is discharged. Any impurities or heavy matter settle in the end or receiving basin, and what light impurities there are in the heating water are carried over by the steam as it is lodged in its reservoir, where it can be blown off two or three times a day with a surface blow-off. There is also a blow-off in the bottom of the dome for blowing off the heavier matter. This we have covered by letters patent and we have a number of boilers using it that are giving the best of satisfaction. The outside of the flues are cleaned with a steam hose through the doors placed in the arch for this purpose.

After the boiler is constructed it is tested under a hydraulic pressure of 50% above the working pressure. All seams and joints are made perfectly tight. The boiler is suspended or set on columns, the forward or front column being bricked solid in the arch, and the center and rear columns having a space of 1 in. to allow for contraction or expansion without injuring the brickwork or setting. The drawing will show the manner of bricking or tiling, and the course the gases take after leaving the grates is indicated by the arrows.

The following are the tabulated results of a test made on a Jackson & Church boiler at the plant of the National Cycle Manufacturing Co., of Bay City, Mich., March 19, 1896, using Pittsburg bituminous lump coal, containing when fired 3.33% of moisture. The ordinary fireman did the firing:

Duration of test, continuous run	10 hrs.
Coal consumed dry (including wood)	3,218 lbs.
Percentage of ash	9.48
Water evaporated at 36.8° F.	24,825 lbs.
Coal per sq. ft. of grate per hour	14.3 "
Boiler pressure	79.4 "
Temperature of feed water	36.5° F.
Temperature of escaping gases	375° F.
Temperature of boiler room	54.8° F.
Stack draft	0.25 ins.
Percentage of moisture in steam	0.38
HP. per hour	80.8
Water evap. per lb. of coal (actual) 36.3°	7.714 lbs.
" " " " from and at 212°	9.061 "
" " " " combustible (act'l) 36.3°	8.593 "
" " " " from and at 212°	10.033 "
" " " " " " " " 212° (allowing for loss of condensation in dome)	10.109 "

Our boiler will cost about the same per horse power to build as an ordinary tubular boiler of the same capacity. We could put it on the market at the same price, with the same front, trimmings, stack, etc., but we take pride enough in making a good article to try and get a little better price and furnish a more elaborate front, more back-stays with washers, two pop safety valves, and the very best of flues and all kinds of trimmings. In bricking up our boiler the cost is no more than with the ordinary tubular boiler, the actual cost depending altogether upon the location, the cost of material and labor. We can brick up the boiler here at a cost of $1.80 to $2.50 per HP. This is one thing we have aimed to keep down in the construction. It will be noticed from the drawing that the setting is very low, a 125-HP. boiler requiring only 9 ft. in height of brick work.



A NEW WATER TUBE BOILER.
Jackson & Church, Saginaw, Mich., Manufacturers.

THE NEW HOLYOKE WATER-POWER DAM.

By Sanford E. Thompson,* Assoc. M. Am. Soc. C. E.

(With two-page engraving.)

The water power at Holyoke, Mass., is by far the largest in New England. It surpasses those at Lowell and at Lawrence by thousands of horse-power, and while others in the country exceed it in theoretical horse-power, it is probably the largest developed power in the United States. The average total head is about 60 ft. The drainage area of the Connecticut River above Holyoke is 8,000 sq. miles, while that of the Merrimack at Lowell is 4,000 sq. miles, and of the Hudson at Mechanicsville, 4,500 sq. miles. Appleton Wis., on the Fox River, the rival of Holyoke in the west as a paper manufacturing center, has with its three dams a total of only about 10,000 theoretical horse-power, or approximately one-third of the developed power at Holyoke.

The Holyoke power is of special interest to engineers at the present time from the fact that a stone dam with a clear overflow of 1,020 ft. is in process of construction. Through the courtesy of Mr. E. S. Waters, Chief Engineer of the Water Power Co., and of the other engineers, details of the new work have been obtained.

*Newton Highlands, Mass.

The Present Wooden Dam.

The first dam across the Connecticut River at Holyoke was completed in the fall of 1848. The gates were closed and the mill pond filled in November of that year, but before the water reached the crest of the dam the entire structure, with the exception of about 75 ft. at one end and 150 ft. at the other, gave way from the pressure of the water and toppled over. Although no plans remain of this dam, the failure is supposed to have been due to the fact that the upstream face was built with too steep a slope.

The following year, 1849, a second dam, which still remains and which will be used until the completion of the new stone dam, was built. A section of this dam, also showing the apron which was added later, is shown in Fig. 1.* This wooden dam is 1,020 ft. in length between abutments, and about 30 ft. in height, and it was entirely completed in one season. The total cost, as stated by Mr. Herschel in his paper, was $150,000, which would represent a much larger amount, probably $250,000, at the present date. The original dam was built as shown in the left hand portion of the section, Fig. 1, with no apron, and as a natural result the water flowing over the crest, aided by timber and blocks of ice which flowed down the stream, commenced very soon to cut away the ledge below the dam and in some places to undermine it, while the eddies caused by the falling water thrust the logs and ice back against the timbers and, in fact, tore some of them completely out. To prevent this action of the water, and protect the face of the dam, the apron shown in the section was built during the years 1868, 1869 and 1870, and this apron was solidly filled with stone. This filled the hole in the ledge and strengthened the old dam, but it did not prevent further erosion. In fact, the slope of the plank, while tending to throw the water away from the dam, was built at an angle corresponding very closely to the dip of the ledge below it, so that the cutting still continued. In 1895 the rock had been excavated by the force of the water to a depth of 25 ft. or 11 ft. deeper than the base of the apron. This hole extended the entire width of the river and for a length down the stream, in places, of over 100 ft.

From 1849 to 1879 practically no repairs were made upon the dam, except those in connection with the construction of the apron, but in the latter year a break occurred in the plank covering the dam, and during the next few years so much trouble was experienced that in 1885 the entire surface was replanked. At the same time a line of sheet piling was driven longitudinally through the dam about three bents back from the face, and on each side of this sheet piling gravel was dumped and puddled or "hydraulicked." A full description of these repairs and the methods of making them are given in a paper by Mr. Herschel, read before the American Society of Civil Engineers in 1886 (see footnote). As far as can be learned by the writer, no careful examination has been made of the timbers or of the condition of the gravel filling since the work in 1885. From the fact that an immense amount of gravel has been found in the river bed below the dam, and as the leakage through the dam has been rapidly increasing from year to year, it appears that the repairs were not so permanent as it was hoped they would be. In 1891 it was decided to build a stone dam below the present wooden dam, and as near to it as would be consistent with the condition of the river bed.

Since 1885 two breaks have occurred in the surface, but these were probably due to the decay of the timbers rather than to the rotting of the plank, since the latter had only been in a few years. The first of these two breaks occurred in 1893. The hole was about 4 × 6 ft., and its depth, measured vertically below the top of the dam, was about 11 ft. The plan adopted for repairing these breaks was of an entirely different character from that used by Mr. Herschel.

The whirlpool occasioned by the leak was noticed late one afternoon, when the water was between 3 and 4 ft. below the crest of the dam. In all probability the hole had been made, or at least started, during the spring freshet, but its effects did not show until the low water of the following summer. The first thing done was to make a survey showing the exact location. A boat was rowed to the spot and sufficient horizontal measurements taken from two points on the crest of the dam to exactly locate the irregular outline of the hole. A pike-pole, plumbed by means of spirit levels, was used instead of a plumb-bob. The sketch thus made was taken into the office, and knowing, of course, the slope of the dam, an exact plan and section could be made. It was found on examination that a log, and also a railroad tie, had been caught in the hole and must be removed. The hole, as has been stated, was about 4 × 6 ft. The timbers of the dam are about 6 ft., c. to c., so that in order to give a sure bearing on these timbers a cover 8 ft. sq. was made. This cover consisted of two thicknesses of 3-in. chestnut plank, spiked together so that the grain of one set ran at right angles to that of the other. The suction was so strong that the plank could not be let down without some guide, and from measurements scaled on the sketch a horse was made and set up on the slope of the dam just above the hole, and guyed by four pieces of timber, two from the top and two from the bottom, to the crest of the dam. To sink the cover, about 400 lbs. of pig iron had been wired to the planking. The cover was let down edgewise by two guy ropes running from the top of the horse. A third rope passed from the edge of the cover to the boat, and as soon as it had touched the dam the boat was rowed upstream so as to tip the cover down on to the hole. It gradually tipped until it received the full force of the suction, when it went down with a rush. The break was entirely repaired within less than 24 hours from the time it was noticed. At the time this repair was made the water had been purposely drawn down by the mills until the depth over the hole was about 5 ft. It is supposed that the break was caused by the corner of one of the timbers, which was probably waney in the first place, rotting away and allowing the end of the plank to be pressed down by the weight of the water above it. In 1894 a similar break occurred. This was slightly smaller, about 4 ft. sq., and was not quite so deep below the crest of the dam. It was repaired in the same way.

The stopping of these two leaks constitute all the repairs bestowed upon the main dam during the last twelve years. Occasionally planks have had to be replaced on the apron, and last year, after the spring freshet, a hole about 20 ft. long by 6 ft. high was found in the face of the crib-work of the apron, extending back under the apron the length of one crib, or about 6 ft. The logs were cleanly broken off and a sufficient number were left directly under the planking to prevent any sagging, and it was not even thought necessary to replace them.

The leakage had been gradually increasing until in 1895 there was a loss of 118 cu. ft. per sec., which, under a head of 60 ft., is equivalent to a loss of 800 theoretical horse-power.

The New Stone Dam.

Surveys for a new dam were begun in 1891. As shown by the plan, Fig. 2, the crest line of the new stone dam is at one end 112 ft. and at the other end 132 ft. below the apron of the old dam. This distance was necessary on account of the erosion made in the bed of the river by the falling water. The total length of the rollway between abutments is 1,020 ft. At the end next to South Hadley Falls the present abutment is to be extended so as to form a wing wall 12 ft. above the crest of the dam, as shown in Fig. 3. At the Holyoke end is a similar abutment of the same height, shown in Fig. 4. Both of these abutments have had to be moved on the plans, since their first location, a little further from the center of the river, to clear entirely the hole in the bed of the river.

The bed of the river for a part of the distance across is of blue slate, and, for the remainder of the way, red sandstone, so that no difficulty was encountered in obtaining a suitable foundation.

An outline section of the main dam is shown in Fig. 5, and another section in Fig. 6. The upper part of the curve on the down-stream face of the dam is that of a parabola, the parabola selected being the curve of freely falling water flowing 4 ft. in depth over the crest of a dam. The parabola extends down the slope as far as the point of reversing, and below this the curve is a cycloid, selected as the "curve of quickest descent." The up-curve at the extreme toe is designed to break the force of the water and prevent its cutting into the ledge beyond. The slope of the back or upstream face is equivalent to a batter of 1 ft. in 5 ft. It is stepped off every 5 ft. in height in order to afford a footing for the coffers, as will be described further on.

Instead of starting the rubble masonry for a foundation for the toe courses on the ledge, there is a layer of concrete averaging about 1½ ft. in thickness, the top of which is at Elev. 63.10, or about 3 ins. below the end of the headers of the lowest course of cut stone. Beyond the extreme course of the toe, concrete is also laid for a footing against the ledge and also to fill any irregularities in the ledge below. Where the ledge is high, it is blasted off. The stones of each of the first eight courses are dogged together horizontally with galvanized iron dogs countersunk into the surface. To tie together the stones of the coping galvanized iron dowels are used instead of dogs, except in two cases, where the tie has to be put in after the stones are in place. Plans and sections in full of dam and abutments are shown in Figs. 2 to 6. The following is a statement of the quantities of material in the completed dam, as submitted to bidders:

Quantities:
- 34,500 cu. yds. rubble stone masonry.
- 1,825 cu. yds. granite dimension masonry in upper course of dam.
- 7,000 cu. yds. granite dimension masonry in face of dam.
- 2,500 cu. yds. split granite masonry in back of dam.
- 2,300 cu. yds. granite dimension masonry in abutments and wing walls.

Surface Fine Hammered or Pointed (given to assist contractor in making his bids but which is not to be paid for separately):
- 16,150 sq. ft. fine six-cut hammered work on top of dam.
- 170 sq. ft. fine six-cut hammered work on top of waste dam.
- 51,500 sq. ft. facing of dam, rough pointed.
- 8,700 sq. ft. inner facing of abutments and wings.
- 5,000 sq. ft. top of abutments and steps.

These quantities are to be considered as approximate only, and the Holyoke Water Power Co. reserves the right of increasing or diminishing any of the above quantities of masonry as may be deemed necessary by the engineer, but such increase or diminution in none of them shall exceed 20%.

The contract for the entire work, with the exception of the excavation, which was done by the company, was signed in February, 1895, between the Holyoke Water Power Co. and the Fruin-Bambrick Construction Co., and Henry S. Hopkins, of St. Louis, Mo.

Materials.

The stone for the concrete is broken stone and is brought from the crusher at Westfield, Mass. The stone for the rubble filling is taken from the bed of the river below the dam. All of the granite for the dam is being furnished under sub-contract by the National Granite Co., of New York, whose quarry is situated on Leadbetter's Island, near Vinal Haven, Me. The cement is furnished by the Alpha Cement Co., The Bourse, Philadelphia. The selection of the Alpha brand of cement was the result of competitive tests. Seventeen bidders presented samples. Of these, five were American, four English, five German, two Belgian, and one Turkish. The tests were conducted in accordance with the standards of the American Society of Civil Engineers. The fineness of each sample was found by running it through a No. 50 sieve, containing 2,500 meshes per sq. in., and also through a No. 100 sieve, containing 10,000 meshes per sq. in. The percentage of residue in each case was noted. On account of the great care required in setting the face stones it was essential that the cement should be slow setting, and the requirement was made that the initial set should take place in not less than 30 minutes, and the hard set in not less than 1 hour and 40 minutes after mixing. As a matter of fact, the cement finally chosen averaged from two to five hours in reaching its hard set.

The cement for the briquettes was mixed in the usual way, the percentage of water to be used with each barrel of cement tested being decided by previous experiment. The briquettes were mixed in gangs of four and a Riehle machine was used for

*Reproduced from the paper "On the Work Done for the Preservation of the Dam at Holyoke, Mass., in 1885," by Mr. Clemens Herschel, M. Am. Soc. C. E., Trans. A. S. C. E., Vol. XVI.

testing the tensile strength. Tests were made on neat cement and on mortar containing two parts of sand and one of cement. Some tests were also made three to one, but these were not used in comparing the relative merits. The briquettes were broken after 24 hours, 7, 14 and 28 days and two months, the acception or rejection being based chiefly on the latter test.

In addition to the tests of fineness, of length of time of setting, and of tensile strength, a sample of each brand was tested for color of air pat, for checking and for expansion. The expansion test was made with lamp chimneys, according to the rule for "soundness" laid down in Baker's "Masonry Construction," p. 60. In all of the tests special care was used to preserve perfect uniformity, as comparative rather than absolute results were desired. The temperatures of the water, the air and the cement were maintained at 65° F. and 66° F., the extreme variation being from 62° F. to 67° F.

The sand was taken from the same bank, which was to be used for the mortar of the dam, passed through a No. 20 mesh wire sieve and caught on a No. 30. It was not washed. Briquettes mixed up with this sand in the proportion of two to one gave almost identical results with briquettes mixed of standard quartz sand, and prescribed by the American Society. They gave slightly higher results than when washed sand was used. All tests were made in April, 1895. Whenever desired by the agents of the company furnishing the cement, re-tests were made, but in no case did a re-test change the comparative value of the cement.

The percentage of residue on the No. 100 wire varied in the various brands of samples from 6 to 29%; on the No. 50 mesh, from zero to 7%. Initial set varied from 2 mins. to 3 hrs. 45 mins., and the hard set from 3 mins. to 6 hrs. The 24-hour tests for tensile strength of neat cement, excepting one brand which was withdrawn, varied from 26 lbs. (the next above this was 85 lbs.) to 441 lbs. The 28-day tests for tensile strength (for all the samples the tests were not carried to two months) varied from 411 to 870 lbs. The results of the tests of some of the brands appeared to show very strongly that some of the samples were "doctored." This was especially noticeable in the 24-hour and seven-day tests, where the high results would seem to show that the agents expected the result to be determined on a short time test and arranged their samples accordingly.

Of the 17 brands presented to Mr. Waters, the Chief Engineer, he selected five, and of these five the contractor accepted the Alpha brand. The test upon which the selection of the Alpha was really based was made from cement taken from a barrel which was one of the lot being used on a job in the city, without the knowledge of any agent of the company. It was thus strictly a commercial sample. The test of this sample of Alpha cement up to 28 days was as follows:

Residue on No. 100-mesh sieve	13%
Residue on No. 50-mesh sieve	1%
Time to reach initial set	2 hrs. 30 mins.
Time to reach hard set	5 " 10 "
Tensile strength per sq. in., neat cement after 24 hours	243 lbs.
Tensile strength per sq. in., neat cement after 7 days	642 "
Tensile strength per sq. in., neat cement after 28 days	871 "
Tensile strength per sq. in., 2 parts sand to 1 cement after 7 days	202 "
Tensile strength per sq. in., 2 parts sand to 1 cement, after 28 days	436 "
Color of air pat, checking test, expansion, all good.	

A few of the cements were submitted to a chemical test to ascertain the percentage of sulphuric acid and the percentage of magnesia. The Alpha cement showed the lowest percentages of any of the cements tested, 1.04% sulphuric acid and 1.49% magnesia.

In actual construction, one barrel in every ten of the cement used on the dam is tested for tensile strength, and the results of these regular tests show even more clearly than did the original test the superiority of the Alpha cement. Several cars received last summer tested over 1,000 lbs. per sq. in. in seven days. During 1896 the tests averaged even higher than in 1895, one reason probably being finer grinding, many samples leaving only 7% or 8% residue on a No. 100 sieve. The accompanying table shows the total averages for the years of 1895 and 1896:

Table Showing Average Results of Tensile Tests of Cement for Holyoke Dam made during 1895 and 1896.

		24 hours neat.		7 days neat.		7 days 2 to 1 (laboratory)		7 days 2 to 1 (mortar)	
Season.	No. of cars.	No. of briq't's.	Av. strain, lbs. per sq. in.	No. of briq't's.	Strain, lbs. per sq. in.	No. of briq't's.	Strain, lbs. per sq. in	No. of briq't's.	Strain, lbs. per sq. in.
1895	56	216	222	190	668	210	222	273	225
1896	28	103	242	102	816	112	413	151	387

The uniformity between the results obtained from samples made up in the laboratory and those taken from mortar mixed up on the works is to be noticed particularly. For the latter samples the man who did the testing of the cement went out on to the works and shoveled from the mortar bed enough mortar to fill a gang of four briquettes.

The sand used in the mortar is obtained from a bank in Holyoke, about a mile and a half from the dam. It is screened once to remove the stones. A sample of this sand if put in a glass of water and shaken up hardly clouds it. The high tests obtained with the mortar are probably due to the absence in this sand of clay and loam. No better practical test of the mortar could be made than occurred during the spring freshets of 1896. There was a delay in receiving the face stone of the dam during the summer of 1895, and therefore the contractors put in a large amount of rubble and ran it up to a point at the top, thus forming a ledge extending partly across the river and having for its apex a single line of stone. When the water went down sufficiently to get at the work, an examination was made of the masonry and it was found that only two or three stones had been moved.

Special Tests.

In order to illustrate the necessity of some of the requirements in the specifications, and also to test more thoroughly the cement, a series of experiments were made from time to time, a number of which are sufficiently interesting to be placed on record.

One of the paragraphs in the specifications stated that "under no circumstances will masonry be allowed to be laid in water." To illustrate the value of this clause a batch of concrete was mixed up in the exact proportions and by the same method as would be used on the works, 1 part cement, 2¼ parts sand and 5 parts broken stone. This, as soon as it was mixed, and before it had set, was placed in a pail two-thirds full of water. The concrete was mixed on a board and shoved from this board by means of large trowel into the pail. It was allowed to remain thus for twelve months, the surftce being kept at all times under water. The surface of the concrete hardened soon after it was deposited and it was not long before it would withstand a heavy blow. When the year was up the water was poured off, the pail turned upside down, and the concrete allowed to fall out. Instead of its being in one mass it had separated itself into three fairly distinct layers. On the surface was a layer ¾-in. thick of what appeared to be neat cement. This was as hard as would be expected of neat cement which had set for a year. Below this was a layer about 2½ ins. thick, containing a few pieces of broken stone but being composed chiefly of sand with enough cement to hold it together. At the bottom was a mass between 2 and 3 ins. thick of sand and stone nearly as separate and clean as before being mixed with cement, there being no cohesion whatever. It is known, of course, that action somewhat similar to this will occur when unprotected concrete is dropped through a great depth of water, but it appears to the writer that this test shows the process of separation to be much more general than is understood by the majority of engineers. It may be urged that a small mass, such as used in the experiment, dropped through a small depth of water, corresponds to a large mass dropped through a great depth; Alpha cement, too, is finer than most other brands and slower setting. But, however much these conditions may have affected the result, the conclusion remains that concrete should never be laid under water without carefully experimenting with the particular cement to be used and with conditions exactly corresponding to those to be followed in practice. The fact that the surface of the mass sets quickly and becomes very hard is apt to mislead one into the belief that the entire mass is solid.

The effect of the immersion in water before it had set was shown by another simple experiment. A ball of mortar about 2 ins. in diameter was immersed as soon as it was mixed in water having a temperature of 41° F. The time of initial set of mortar whose cement was taken from the same barrel was in air 28 mins. A ball of mortar was allowed to remain for 18 hrs. On examination it was found to be hard on the surface, but of the consistency of mud in the inside. After 28 days it had become hard throughout and seemed all right regarding its setting qualities. From this and similar experiments the conclusion was reached that mortar placed directly in water before gaining any set lost about 75% of its strength and perhaps more. It was noticed that a very quick-setting cement treated in this same manner lost a much smaller proportion of its strength.

To illustrate the effect of plaster of Paris into a sample of cement 2% of plaster was mixed. Tests showed a gain of 87% in strength over the regular test in 24 hours. A briquette of pure plaster of Paris was mixed up and after 24 hours it tested 250 lbs., but a similar sample of pure plaster allowed to remain one day in air and then in water for 27 days had lost 33% of its strength.

An experiment was made to illustrate the effect of re-burning upon Portland cement. A bag of cement which had become slightly crusted on the outside by exposure to the moisture of the air, reached when mixed with mortar its initial set in three hours and five minutes, and its hard set in seven hours and 35 minutes. Cement from the same bag was placed in a pan and allowed to remain in a furnace for 20 minutes, the color becoming cherry red. After cooling for 2½ hours, the initial set took place in two minutes, and the hard set in 22 minutes. The tensile strength was reduced by this process, being only 79% of the unburned. Of course it is well known that a cement manufacturer can furnish either slow-setting or quick-setting cements, but the great variation in this quality which is caused simply by hydrating or purging, which process is merely slaking in the air, is not generally recognized by engineers. The following table, taken from actual experiment, may be of interest:

	Initial set.	Hard set.
Not purged	58 sec.	2 min. 04 sec.
Purged 7 days	1 min. 23 sec.	1 min. 55 sec.
Purged 25 days	27 min.	2 hrs. or more

The tensile strength, after seven days, of cement which is not purged will be only about 10% less than that of a commercial sample which has, of course, been purged in the usual way. If for a special purpose a slow-setting cement is desired and the test shows the material to be quick setting, it may be made slow-setting by simple exposure to the atmosphere.

The specifications stated that no masonry "is to be built in freezing weather, except by permission of the engineer." A number of experiments were made to show the results of freezing upon mortar. As this is a subject upon which numerous experiments have been made it will not be worth while to go into the tests in great detail. Suffice it to say, the conclusion reached was that freezing reduced the strength about 50%. A marked exception to this, however, is noticed when a very quick-setting Portland cement is used. Freezing seems to affect this comparatively little.

The specifications stated that "all iron used for dogs or pins shall be galvanized." To illustrate the effect of galvanizing, a piece of galvanized iron was embedded in cement and allowed to remain six months. The mortar was then broken open and the iron examined. It was found that the galvanizing had all disappeared, but that the iron was clean and bright.

An interesting series of experiments were made to show the effect of an increase in the amount of sand and mortar. Alpha cement was used and all tests of tensile strength were made at the end of 28 days. The result was as follows:

Proportions.	Tensile strength, lbs. per sq. in.	Proportions.	Tensile strength, lbs. per sq. in.
Neat cement	889	5 to 1	183
1 to 1	805	6 to 1	121
2 to 1	589	7 to 1	71
3 to 1	343	8 to 1	53
4 to 1	204	9 to 1	44

Contract Work.

As has already been stated, the rock excavation for the dam was done by the company by day work. This was commenced in 1893 and completed in 1896. The total quantity excavated was about 13,000 cu. yds. For the toe of the dam the excavation averaged about 8 ft. in depth. The trench for the toe is about 15 to 18 ft. in width, extending, of course, the entire width of the river, and upstream from this the ledge was stepped off sufficiently to give a good footing for the rubble as far as the back face of the dam. Soon after the excavation was commenced a trench or channel 17 ft. in width and 600 ft. long was cut parallel to the flow of the river to an average depth of 10 ft. to drain the site of the dam. This channel is not far from the center of the river and the slope is 2 ft. in 600, the bottom at the upper end being level with the foundation of the dam. The ledge across the river below the toe of the dam is comparatively uniform in grade. As has just been stated, the excavation for the toe is about 8 ft. in depth for nearly the entire length of the dam. At two or three places it drops down to 3 ft., which is the minimum. It will be seen that the toe has thus an exceedingly good footing, while very little excavation or additional masonry is required there to level it off.

The contract was signed in February, 1895, and the first stone was laid in July of the same year.

For conveying the materials to their location on the dam there is suspended directly above the work and on a line with the dam a 2-in. cable, furnished by the Trenton Iron Co., of Trenton, N. J. A frame tower is built on each side of the river; the one on the Holyoke side, 120 ft. high, and that on the South Hadley side, 100 ft. high. The base of the former is also 20 ft. higher than the latter, so that the slope of the rope between towers, if there were no sag, would be 40 ft. Since all of the material except the rubble is furnished from the Holyoke side, the travel of the load is generally down grade. The base of the Holyoke tower is about 22 ft. above the crest of the dam. It is about 25 × 30 ft. at the base and is a plank skeleton frame well bolted and tied together with diagonal braces. The face farthest from the river is vertical, while that toward the river is built on a batter. It is guyed sideways, and also back to the anchorage. The cable passes over sheaves at the top of the towers, so as to bring the strain upon the tower as nearly vertical as possible, and is anchored to the solid rock at each end. The total distance between anchorages is 2,200 ft. and the span between towers is 1,615 ft. The cable, which is designed for a safe load of from six to seven tons, is the longest for its strength in the world. A 50-HP. engine in the Holyoke tower, with two drums, one of which moves the carriage along the cable and the other hoists and lowers, furnishes the power. The carriage is capable of making a round trip of average length, that is, to the middle of the dam, every ten minutes; this includes time picking up, hoisting and dumping load as well as the time of horizontal conveyance. Assuming it to carry an average load of 3 cu. yds. of material, this would give a total capacity of 18 cu. yds. per hour, or 180 cu. yds. per day of ten hours. In actual practice there would, of course, be delays incidental to the work, but on the other hand, as the rubble is taken from cars running to about the center of the dam the average haul of this is about one-half what it would be if it all came from the Holyoke shore. The wires of which the cable is constructed are of such special shape as to form a nearly solid rope and to present on the outside a smooth cylindrical surface. The makers state that the ropes weigh from 92 to 96% of the weight of a solid steel bar of the same diameter. The carriage and button rope were designed especially for this work by the Lidgerwood Mfg. Co., of New York.

As there is no storage room near the end of the dam, any excess of granite has to be unloaded in a field about a mile below the dam, and after inspection loaded on cars again and taken to place. The stone is handled with dogs. The cement and sand are taken by the cable from the Holyoke end; for use with the face stone the mortar is mixed on the dam close to where it is to be used. The rubble, as has already been stated, is quarried from the bed of the river below the dam. A track runs from this quarry to the dam, and the stone is loaded on to skips on cars drawn by horses. At the dam the cable takes the skips and carries them to place. The first course of stone laid was the third from the toe, as the beds of this are the nearest vertical.

The method of providing for the water which falls over the dam or the leakage through the dam, as the case may be, is as follows: As has already been stated, there has been excavated not far from the center of the river a channel extending down the river parallel to its direction. There is also close to the South Hadley shore a natural channel, the grade of whose bed is nearly the same as that of the artificial channel. No masonry has as yet been built across these channels, so that the water at present is flowing through both of them. When it is desired to fill up these openings in the dam (this will be done before a very large portion of the rest of the work has been built) a coffer will be constructed just above the line of the back of the dam across one of the channels, and the water thus turned through the other channel. As soon as the dam back of the coffer has been built up to the level of the first step, or to a height of 5 ft., the coffer will be removed and placed instead just above the other opening in the dam, so as to close the channel at that point and turn the water over the masonry built in the first channel. Back of the second coffer 10 ft. in height of dam can be constructed, when the coffer can again be changed. By this plan of alternately filling the two openings the total head against the coffer dam is in no case more than 5 ft., plus the depth of water flowing through the opening, and the steps in the back of the dam provide a base so that the plank will have a good foundation and need not be of a length to extend clear to the bed of the river.

Every stone is laid to line, grade and batter, and extreme care is exercised to see that the work is accurately done. The stones are levelled and lined by instruments. The batter is obtained from templets furnished by the company. The joints of the face stone are only ¼-in. and they are so nearly vertical at and near the toe that it is necessary to grout them there. The mortar is poured in, and a sword is run through the joint to make sure that the mortar reaches every crevice. The rubble for the bed which is directly under the stone is laid up to within 2 or 3 ins. of the granite several hours in advance of the latter, in order to set sufficiently to bear the weight. The care with which these stones are laid is shown by the fact that a gang of masons average only about five stones per day. The rubble is laid with full joints and under close inspection. Joints which are difficult to fill by spreading the mortar are left open and grouted. The mortar is all two parts sand to one of cement. It is mixed first dry and then wet, in an ordinary mortar box, one batch at a time. An inspector is stationed at each mortar box to see that proper care is given to the mixing, and the experiments already described of tests of mortar in comparison with tests of the laboratory mixture prove the thoroughness of this part of the work.

Each cubic yard of rubble masonry requires ⅞ barrels of cement. The weight of the granite is 163 lbs. per cu. ft.; of the slate from the river bed, 170 lbs. per cu. ft.; and of the sandstone from the river bed, 180 lbs. per cu. ft. The following figures show the amounts of masonry laid during the seasons of 1895 and 1896:

	1895.	1896.
Rubble	4,800 cu. yds.	7,100 cu. yds.
Split granite	100 " "	260 " "
Concrete	918 " "	1,175 " "
Abutment stone	..	2,500 " "
Face stone	.. ..	1,000 " "

Figs. 7 to 10, from photographs taken during the summer and fall of 1896, present different sections of the work. Fig. 7, looking toward the Holyoke shore, gives a view of the ridge of rubble core, which was carried up in advance of the face work. Fig. 8, taken near, and showing in the background the Holyoke spillway, gives a view of a portion of the courses of cut stone in the toe of the dam. The ledge in front of the dam is at this point as low as at any place in the entire length. Fig. 9 shows the cable unloading cut granite from cars on the Holyoke side. Fig. 10 is from a photograph taken just below the gate house, looking across the head of the first level canal and showing the Holyoke tower. On the right of the view in the distance may be seen Mt. Tom.

A walk down the river to the yard where the granite is first unloaded from the cars for storage gives to one a view of a pile of cut granite, such as probably has never been collected outside of a quarry in any one place in this country. Imagine a line of stones, most of them of uniform size, piled 4 and 5 ft. high, and extending a length along the track of 300 ft. The height of the pile is nearly 10 ft. and its width is about 16 ft.; but it is not so much the number of stones and the size of the pile that impresses one, as the quality of the granite and the nicety of the workmanship. The specifications for the Holyoke dam have been noted all over the country for the extra quality of work which they require, and the remark has been made by more than one engineer and contractor, that it might do very well to put such things in specifications but that no contractor would furnish material exactly fulfilling the requirements. The strange part of it is that the stone does come up to the requirements of the specifications. Some of the stones are almost as smooth as a marble slab; too smooth, one would say at first thought, to make a strong joint. The specifications for the back or upstream face state that "the outer faces shall be kept full and rough pointed so that no projections will exceed 1 in. above the plane of the stone." Instead of varying from ½ to 1½ ins., as one might naturally expect if the specifications were roughly interpreted, the extreme of the projection is exactly 1 in., and sighting along the surface shows it to be nearly as regular as would be required for beds and builds in ordinary nice work. Of course, this nicety of workmanship is due primarily to rigidness of interpretation of the contract and to care in inspection, yet the workmanship in the quarries can be appreciated from the fact that out of a total of about 1,600 pieces of stone received, only 20 pieces have been finally rejected. As each car is unloaded, it is inspected and every stone is tried with a templet, and some of them which do not exactly come up to requirements are marked for recutting.

The engineers of the Holyoke Water Power Co. who have this work in charge, and through whose courtesy the facts for this article were obtained, are Messrs. Edward S. Waters, Treasurer and Hydraulic Engineer; James M. Sickman, Engineer in Charge of Construction; Robert Ranlet and W. E. Sawin, Assistant Engineers. Mr. Sawin drew the plans for the work. In addition to these engineers there are employed on the work while it is in progress six assistants, three of whom are inspectors.

In Fig. 11 is shown a plan of the City of Holyoke and an outline of the canals. The total head from the crest of the dam to the tail-water from the third level canal at the average height of the river is 60 ft.; the fall from the first level to the second level is 20 ft.; from the second level to the third level is 12 ft.; and from the third level to the river at its average stage 28 ft. A few of the mills discharge from the first and second level canals directly into the river, but most of the water is used three times. The average daily flow during the year 1895 was 11,951 cu. ft. per sec., which is equivalent to 82,000 theoretical horse-power, average. The minimum power of the river during ten to eleven months in the year may be estimated at 30,000 HP. The developed power of the wheels is about 30,000 HP. Fifty corporations take water, all but ten of whom use it 24 hours in the day. Paper-making is the principal industry. The power is considered in three divisions: Permanent power, owned by certain of the original corporations who have the right to use a certain amount of water at all times during the year; non-permanent power, rented to corporations with the understanding that the amount of water which they use will be regulated by the amount flowing in the river; and surplus power, which is any excess distributed among the consumers. Twice during each 24 hours an engineer from the Holyoke Water Power Co. makes the rounds of the mills, and by the amount of opening of each speed gate and the differences in level between head-water and tail-water determines the number of horse-power being used by each wheel. The new dam will not probably provide power for any new industries but as all leakage will be stopped the present consumers can be more satisfactorily supplied and there will be a gain in revenue to the company on account of the extra amount of water and therefore the extra amount of power which can be used by the present mills during the periods when no water is flowing over the dam.

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The bill to abolish the Board of Examiners of the New York City Building Department and establish in its place a Board made up of civil engineers and architects, which recently passed the New York legislature as announced in our issue of April 29, fails to become a law through the disapproval of Mayor Strong. The harm which the Mayor has done by this veto and the far-reaching extent of this injury would be difficult to estimate. The arbitrary and unjust acts of the present Board of Examiners were fully reviewed in our issue of Feb. 4, and we need only repeat here that under the present interpretation of the Building law, the members of this Board are invested with an autocratic power over every piece of building operations in New York city. They are responsible to no one, their acts are not subject to review by any court, they can and do refuse to give any reasons for their decisions, and from their fiat there is absolutely no appeal. That this is a dangerous amount of power to place in the hands of any man or set of men goes without saying; and to make matters worse, four-fifths of the members of the board are selected by a set of private trade organizations, which are only in a small degree representative of the interests which are affected by the Building Law's administration. The whole system is in fact a reversion to the old system of government by trade guilds which flourished in the Middle Ages; and like that, its tendency is to encourage monopoly and prevent the introduction of improvements.

We feel warranted in calling the especial attention of our readers to this matter, because the action of New York city upon matters of building construction is apt to be taken as a precedent. Engineers and architects throughout the country should understand that the reason why concrete fireproof construction is "turned down" in New York and fireproof construction in hollow tile is required is because the decision on this matter is placed in the hands of a set of men who are incompetent to pass upon the question involved, and who absolutely ignore the results of experience in other cities and the tests carried out by the New York Building Department itself.

The results of the perpetuation of the Board of Examiners in power are not pleasant to contemplate. It means that the inhabitants of the Greater New York will be compelled to pay a tribute of millions of dollars a year to the tile trust. It means that manufacturers of other forms of fireproofing which compete with tile will be to a large extent driven out of business. It calls a halt upon improvements in fireproof construction. It places a barrier in the way of extending fireproof construction to dwelling houses, tenements, stores, and a large class of structures which could now be built economically in fireproof construction if free competition were allowed to prevail and have its effect upon trust prices. The absurdity of permitting a building to be erected with the old wooden fire-trap construction and forbidding the substitution of fireproof concrete construction would be ludicrous if its consequences in the risk to life and property were not so disastrous.

We do not believe, however, that the victory of the tile trust is destined to be permanent. The world is too large and the march of improvement is too irresistible for the city of New York to be permanently ruled by a set of trade guilds. The experience of Germany in the use of concrete, the experience in many smaller cities in this country where the building laws have not been developed to such a state as to prevent the use of improved methods of construction, the repeated proof that concrete is entitled to rank with the best of fireproof construction—all this cannot be permanently ignored. We firmly believe that fireproof construction will eventually be adopted for all permanent buildings; and that the change will come about through the development of far cheaper, simpler and lighter forms of fireproof construction than those in use to-day. The attainment of that end will mean a great reduction in the annual loss of life and property by fire; and a benefit to the country at large which can scarcely be estimated. It is earnestly to be hoped that the rulings of the New York Board of Examiners may be estimated at their true value by the engineers and architects of other cities, so that progress in the country at large may not be retarded even though it is effectually prevented in New York.

The uncertainty of original surveys in the older States of the Union is perhaps one of our most prolific sources of litigation; and in many cases investors have been compelled, in self-defense, to abandon promising enterprises simply because of actual or threatened trouble regarding boundary lines. Many of these surveys were made by ignorant men and are incorrect in themselves; in others, the lines were carelessly run, monuments were never erected, or were of such a temporary character as to have long ago disappeared; and in some cases the plats bear upon them neither the distances nor the bearings, as is the case with several surveys recorded in Ohio county, W. Va., though these same surveys now cover land in the city of Wheeling valued at $1,000 per front foot. Aside from the crude methods of the original surveyors and the results of careless or ignorant work, one of the most potent causes of uncertainty is due to the fact that the magnetic and not the true meridian has been made the basis of surveys. In the States where no standard has yet been adopted to which all surveyors must conform, each surveyor solves for himself and after his own methods all problems relating to variation, errors of eccentricity, and especially the degree of inaccuracy.

Appreciating the troubles constantly arising from these conditions in West Virginia, the West Virginia Society of Civil Engineers and Architects recently prepared and presented a bill to the Legislature of that State designed to correct the evils referred to. This bill proposes to create a commission of three members, each to be both a civil engineer and a surveyor, whose duty it shall be to determine the true meridian at each county seat in the State and mark the same by two permanent monuments before January, 1899. It is then provided that, after the date named, it shall be unlawful for any surveyor to make any survey in a county where the true meridian has been established without first having his compass or transit adjusted to such true meridian and having obtained a certificate to that effect from the County Surveyor. This certificate must be obtained once each year, and the County Surveyor is required to record the name of the surveyor, the date of adjustment of any compass or transit, the variation of the needle from the true meridian, the length of the needle and the maker's name and the number of the instrument. After the date named all surveys made in the State and all bearings recited therein, conform to the true meridian, under a penalty of not less than $10 nor more than $100. The County Surveyor must personally make all adjustments of instruments, and he is permitted to charge $5 for one instrument and $2.50 for each additional instrument adjusted at the same time for one person.

This bill was not reached upon the legislative calendar and was not acted upon; but it will be again pushed at the next session of the Legislature. It certainly should pass in the general interest of the State, and, as framed, it is a simple and efficient method of establishing a standard for all future surveys in West Virginia.

In a recent issue of the journal "Compressed Air" we note the following:

> The public in general appears to have the idea that using compressed air stored at high pressures on street cars is dangerous. To prove how unfounded is this view, one of the bottles or reservoirs that is used in street cars was tested to destruction by hydraulic pressure in November last, by Charles G. Eckstein & Co., of New York, at the works of Messrs. Watson & Stillman. * * *
>
> Under a pressure of 2,500 lbs. the greatest expansion was a little over 1-16-in.; at 4,000 lbs., 3-32-in. When this pressure was removed the bottle returned to its original measurements. At 4,350 lbs. the greatest expansion was ⅛-in.; at 4,550 lbs., 7-32, and the greatest permanent set noticed was 6-32-in.
>
> At 5,000 lbs. the length of the bottle had increased nearly ⅛-in., and the expansion was 7-16-in.; at 5,280 lbs., ⅜; at 5,730 lbs., 13-16-in. The bottle burst under a pressure of 5,760 lbs. The fracture was very clean, and not even a minute particle of the metal flew. The fracture extended from the neck a distance of 2 ft. down the side of the bottle.

We can hardly believe that our contemporary deliberately intended to mislead its readers; but certainly the idea which the non-technical man derives from the above is that the bursting of the reservoir by hydraulic pressure corresponds to the bursting by air pressure, and that because "not a particle of the metal flew" in the hydraulic test, not a particle would fly were a similar reservoir to burst under an equally high air pressure. Of course, every engineer knows that this is far from being the case. When a steam boiler or an air reservoir or any similar vessel is burst in a hydraulic pressure test, there is very little energy stored in its interior, and the metal merely gives way. But when a similar vessel filled with compressed air "lets go," an enormous amount of energy is liberated and a violent explosion occurs, which, as a rule, tears the vessel containing it to fragments and sends them flying in all directions at great velocity.

To hold up a report of a hydraulic bursting test, illustrated with pictures of the burst reservoir, as proof that "compressed air, stored at high pressure, on street cars is not dangerous" is a proceeding which deserves severe criticism, especially as we notice that our contemporary's article has been copied by some of the daily papers, and its statements are thus attaining a considerable publicity.

There has been a very general attempt to "boom" compressed air as a street car motive power in this country for a couple of years or more, and we regret to say that the above is only a sample of the literature on that subject which has been put before the public by those interested in the companies formed to promote it. Whatever the effect of such misleading statements may be upon the public, they give a bad impression to an engineer, and compel the reflection that there must be weak points in a system which resorts to such methods for exploitation.

It should not be understood from the above that we are claiming compressed air reservoirs to be dangerous. As has often been pointed out, danger is a comparative term. There is probably not as much danger in a properly designed air reservoir as exists in the average locomotive boiler, which we walk beside in the railway terminal station without a thought. But the possibility of an explosion exists in every steam boiler, and so it does in every reservoir filled with compressed air, and there is nothing to be gained in the long run by trying to gloss over or conceal this fact.

The revocation by the U. S. Senate of the late order of President Cleveland, setting aside 17,000,000 of acres as forestry reservations, although it is not yet concurred in by the House, is regarded as a victory of the timber thieves by our esteemed

FIG. 9. CABLE UNLOADING CUT GRANITE ON HOLYOKE SIDE.

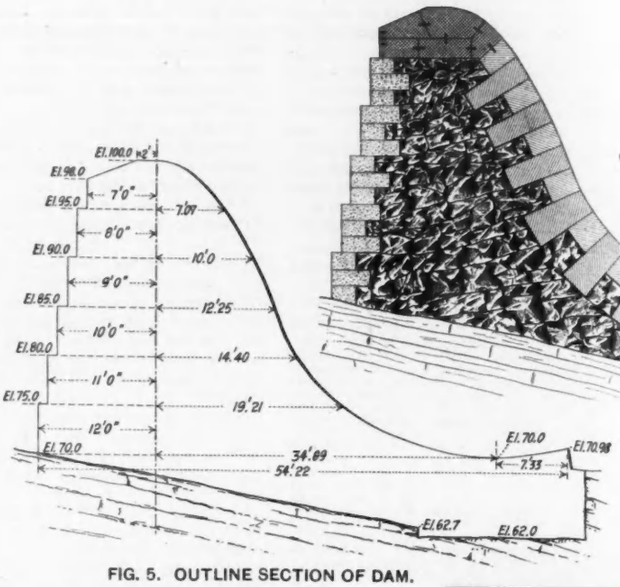


FIG. 5. OUTLINE SECTION OF DAM.

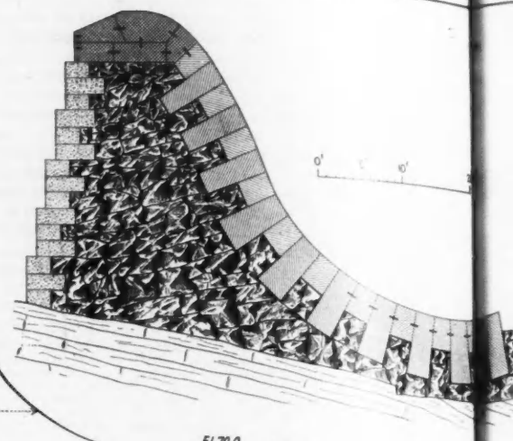


FIG. 6. CROSS SECTION OF DAM.

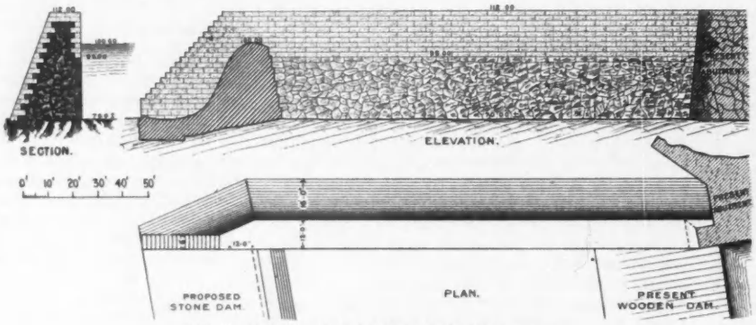


FIG. 4. DETAILS OF DAM AT HOLYOKE END.

FIG. 8. SHOWING CUT STONE IN WITH HOLYOKE SPILLWAY IN

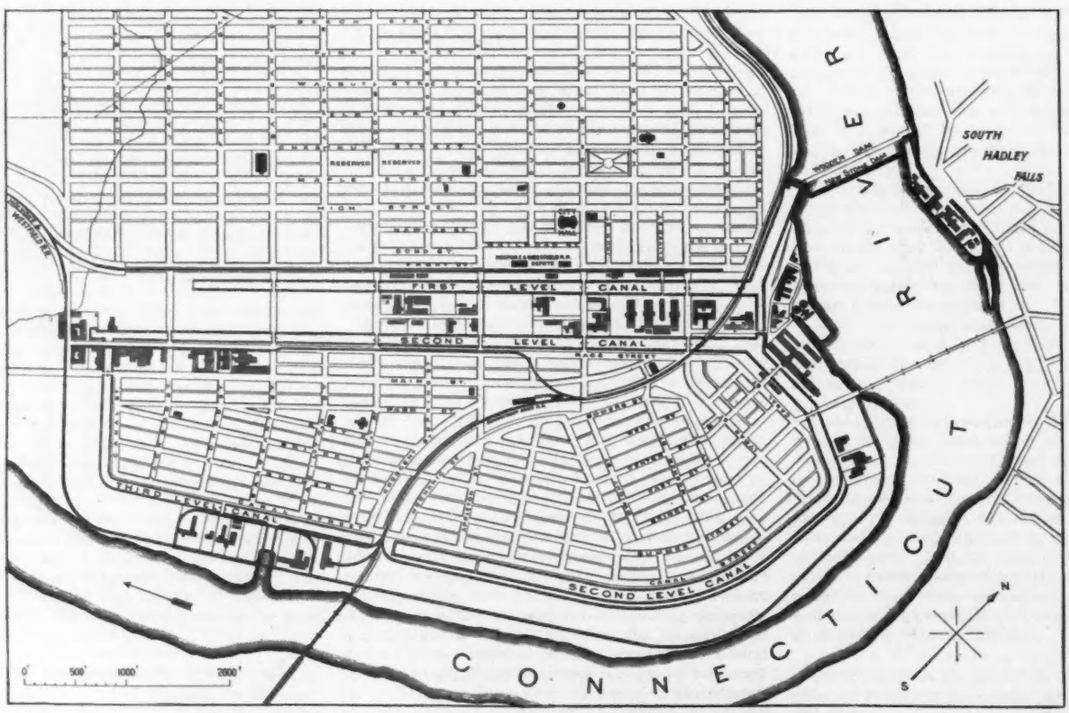


FIG. 11. PARTIAL PLAN OF CITY OF HOLYOKE, SHOWING DAMS AND CANALS.
(Shaded Areas are Manufacturing Establishments and Public Buildings.)

THE NEW ST
ACROSS

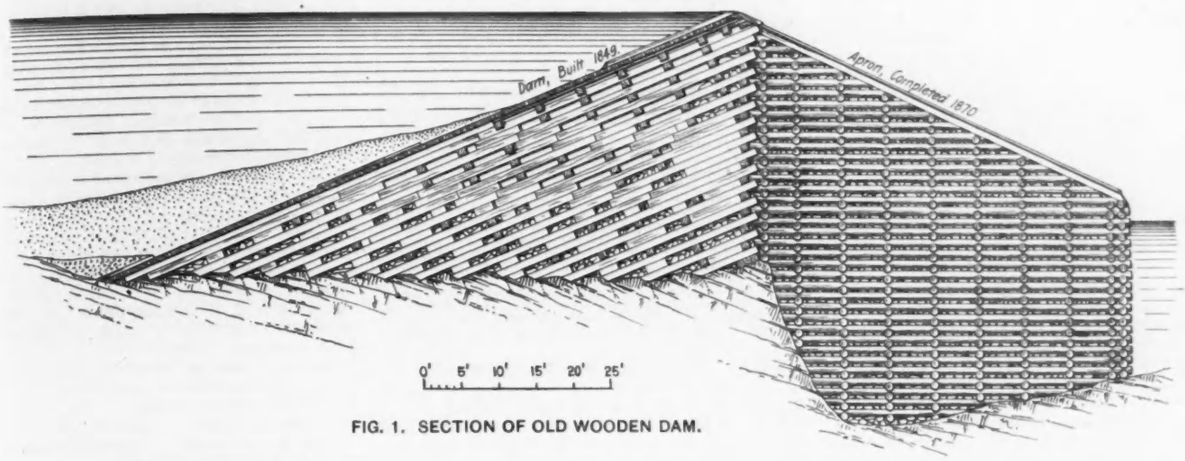


FIG. 1. SECTION OF OLD WOODEN DAM.

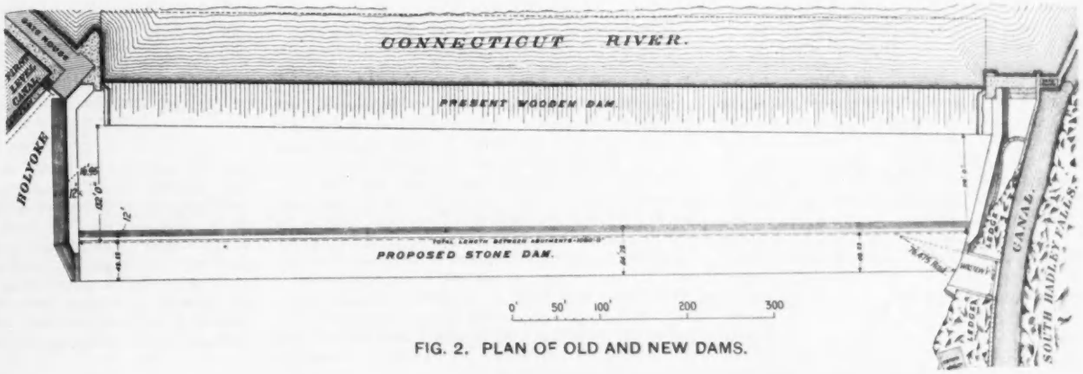


FIG. 2. PLAN OF OLD AND NEW DAMS.

CUT STONE IN TOE OF DAM,
KE SPILLWAY IN THE REAR.

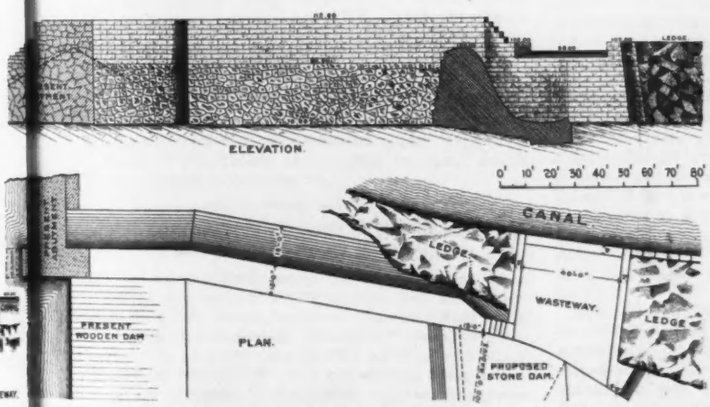


FIG. 3. DETAILS OF DAM AT SOUTH HADLEY FALLS END.

FIG. 7. LOOKING TOWARDS HOLYOKE SHORE, SHOWING RUBBLE CORE.

E NEW STONE DAM OF THE HOLYOKE WATER POWER CO.
ACROSS THE CONNECTICUT RIVER AT HOLYOKE, MASS.

Edw. S. Waters, Chief Engineer.

Fruin-Bambrick Construction Co. and
Henry S. Hopkins, St. Louis, Mo.,
Contractors.

FIG. 10. LOOKING ACROSS HEAD OF FIRST LEVEL CANAL AND SHOWING HOLYOKE TOWER FOR CABLEWAY.

contemporary, the "Journal of Commerce." If this order means a continued, unrestricted spoliation of the public domain and the waste of timber, the "Journal" is right. But, as pointed out in our last issue, the mere withdrawal of millions of acres from public entry, without accompanying laws to regulate their use, utilize the product and protect these lands against abuse, is directly opposed to the true principles of forestry reservation and the purposes intended by those who understand and first promoted the protection of the public forest domain. The Senate and Congress should set themselves to work formulating and enacting laws which will really protect the timber, and at the same time recognize the rights of those who have legitimate demands for wood growing in these regions, and would buy instead of stealing it, if the laws permitted proper disposal of the timber product. Senator Wilson, of Washington, in advocating the revocation of the order of President Cleveland, does an injustice to the "scientific gentlemen from Harvard College," whom he accuses of being responsible for this attempt to restrain people from cutting timber on the public domain needed for domestic, mining and other commercial purposes. The "scientific gentlemen" referred to propose to permit this legitimate use; but to regulate it so as to prevent waste, stealing and abuse of the privilege. The fault lies with a President and a Congress that would simply forbid all entry, for any purpose, upon the public domain in question, and refuse to recognize the true and accepted meaning of forestry preservation and will not provide the means for efficiently carrying it out.

An evidence of the lack of literary training in many engineering schools is the frequent occurrence in engineering literature of the ungrammatical expression "data is." So frequently does it turn up that it is evident a large proportion of engineering writers, editors of engineering journals and secretaries of engineering societies must be under the impression that data is a noun in the singular number. For the benefit of such persons we submit the following quotation from the Century Dictionary:

DATA, n.; plural of datum.
DATUM, n.; pl. data. 1. A fact given; originally, one of the quantities stated, or one of the geometrical figures supposed constructed, in a mathematical problem, and from which the required magnitude or figure is to be determined. 2. A fact either indubitably known or treated as such for the purposes of a particular discussion; a premise. 3. A position of reference by which other positions are defined.

In a quotation from Sir W. Hamilton, given to show the legitimate use of the plural noun "data" the following phrases occur: "propositions which are not original data," "these data." The expression "the data is" is really equivalent to the expression "the facts given is," which would be recognized as incorrect by almost anyone.

On account of a slight accident in our printing office we are obliged to postpone until next week the publication of the discussion on Mr. Prichard's paper, "The Theory of the Ideal Column," which was printed in our last issue.

THE COMPARATIVE ECONOMY OF POWER TRANSMISSION BY GAS AND BY ELECTRICITY.

In a paper read before the Northwestern Electrical Association, at Milwaukee, Jan 21, by Mr. Nelson W. Perry, entitled "Gaseous Fuel as a Means of Cheapening Electricity," the author endeavors to show that electric lighting and street railway companies are in general not doing a profitable business, for the reason that they are trying to cover too widely extended areas or too long distances from a single central station, and that the cost of distribution of electric energy by means of copper wires is too great. He proposes as remedies, first, that the companies should increase the number of generating stations and decrease the length of radii supplied by each, and, second, that each of these electric stations should use gas engines instead of steam engines, the gas being supplied from one central gas producing station. His idea is that it costs far less to transmit power in the shape of coal gas flowing through pipes than it does to transmit power in the form of electric current by means of copper wires. To support this theory he gives an array of figures, some of which we quote as follows:

By this means 1,600 HP. can be delivered under 10 ins. of water pressure through a 12-in. pipe with 25 90° bends at a distance of 5,000 yards with an expenditure of but 1.12 HP. or 7-100 of 1% of the power delivered.

The Gas Light & Coke Company, of London, in its straightaway transmission of 17 miles, which is comparable with some of our longest electrical transmissions, uses 30 ins. initial pressure. With this pressure we could deliver through the 5,000 yards of 12-in. pipe approximately 2,700 HP. with an expenditure of about 17-100 of 1% of the power delivered.

The cost of this pipe, which would weigh 800 tons, would be at present prices $16,000. If we should endeavor to deliver 2,700 HP. electrically to the same distance with the same efficiency of transmission at 10,000 volts, it would require copper equivalent to 47 0000 B. & S. wires, which would weigh 900,000 lbs. and cost, at 12 cts. per lb., $108,000, or six and a half times as much as the gas mains, and require transforming down after it was delivered before it could be utilized.

The above estimates allow nothing for leakage, which in gas mains is sometimes, though not necessarily, very large. According to Mr. James McGilchrist, the losses in leakage on the 2,000 miles of mains of the London Gas Light & Coke Company, through which a maximum of 128,000,000 cu. ft. per day is delivered, is only a fraction over 5%.

Quite a number of technical journals published Mr. Perry's paper in full or in abstract at the time it appeared, and so far as we have seen, its statements have not been questioned, even by the electrical journals, who are generally all agog at any hint that electricity is not the cheapest possible method of power transmission.

Certainly, if Mr. Perry's idea is correct that gas is a cheaper medium than electricity for the transmission of power, the fact ought to be widely heralded. If, on the other hand, he is mistaken in his conclusions, the error ought to be pointed out, for his paper has been given a wide publicity and may mislead many an engineer who is unable to critically examine Mr. Perry's argument.

We have devoted considerable study to this paper and have discovered what appear to be a number of errors, of calculation and of method, which, when properly corrected, cause an entirely different conclusion to be reached from his argument.

In the first place, Mr. Perry's statement that the transmission of 2,700 HP. of gas, of an initial pressure of 30 ins. of water through a 12-in. pipe, can be effected with a loss of only 0.17% of the power delivered, seems to be based on the assumption that the energy lost is only that due to the friction of the gas in the pipe, without considering the efficiency of the gas exhauster and compressor which delivers it into the holder, and the loss due to heating the gas during compression. Moreover, his calculation of this net energy by his own method seems to be in error by about 16%. Taking his assumption of 25 cu. ft. of gas per hour as capable of generating 1 HP., 2,700 HP. equals 67,500 cu. ft. per hour, 30 ins. water column equals a pressure of 156 lbs. per sq. ft., which, multiplied by 67,500 cu. ft. and divided by 1,980,000, the number of foot pounds per hour in 1 HP., gives 5.32 HP., which is 0.197%, instead of 0.17%. A gas exhauster, which takes gas in a heated and expanded condition from a producer, mingled with hot vapor from a scrubber or cooler, and delivers it into a holder at a pressure of 30 ins. of water cannot be a very efficient machine. We should be surprised to learn that its efficiency, based on the final net energy of the compressed and cooled gas in the holder, was as great as 50%. Taking it at 40%, a more likely figure, would raise the expenditure of power to 0.49% of the power of the gas, or practically three times as great as that stated by Mr. Perry.

Next, he calculates that to transmit 2,700 HP. by electric current at 10,000 volts 5,000 yards, with a drop of 0.17%, would require 47 No. 0000 B. & S. copper wires. We do not know how he made this calculation, but we have computed from the formula given in Davis's Tables for Electric Wiremen that it would require only 16 No. 0000 wires for direct current. For simple alternating current it would, no doubt, require more, but for three-phase currents probably less. The quantity of wire would be greatly reduced if the drop is taken at 0.49%. But no practical electric engineer would think of designing a 5,000-yard transmission of 2,700 HP. with any such small drop as either 0.17 or 0.49%. From 5% to 10% would be a much more likely figure. Assuming 5% drop and using the formula given by Davis, viz.:

$$A = \frac{\text{HP.} \times L}{a\ E^2 \times e}$$

in which A is the area of wire in circular mils, L the length to point of distribution in feet, a the percentage of drop, E the voltage, and e the percentage of efficiency of motor, and, taking e at 100 for convenience, we obtain A = 129,924 circular mils. One No. 00 B. & S. wire is given in the wiring tables as 133,000 circular mils, and as weighing 0.4 lbs. per foot. Doubling the distance, making 30,000 feet in length, to allow for the return circuit, and taking, as Mr. Perry does, the cost of copper at 12 cts. per lb., gives a cost of copper of only $1,440, instead of the $108,000 given by Mr. Perry. We may double this $1,440 if we please, to allow for simple alternating current being used, and add what we please for transformers, and the total cost of installation will still be vastly less than Mr. Perry's figure.

The 5% drop we have assumed for the electric transmission is no more than should be allowed for probable leakage by gas transmission; in fact, Mr. Perry himself gives the leakage of a London gas company as a fraction over 5%. Mr. Perry figures the cost of a 12-in. cast iron pipe for the gas transmission at $16,000, and that of the copper wire for the electric transmission at $108,000, or 6½ times as great. Our own calculation for transmission on what we take to be a fairly equivalent basis, viz., 5% electric drop and 5% gas leakage, makes the figure for copper wire only $1,440, and Mr. Perry's figure for cast iron pipe, $16,000, is over 11 times as great.

Besides the initial cost of plant for transmitting power by means of compressed gas in pipes, there are several other things that should be considered before it should be adopted in preference to electrical transmission. Among them may be named: 1. The cost of pipe-laying as compared with that of carrying a wire, either on poles or through underground conduits. 2. The corrodibility of iron pipes as compared with the almost absolute indestructibility of copper wire. 3. The cost of enlargement of transmission plant by laying extra pipe lines as compared with the stringing of additional wires. 4. The value of the material in the gas or electric line in case it should ever be abandoned, cast iron pipe in the ground being practically valueless for sale as second hand material, while copper wire is worth about its weight in copper ingots. 5. The uncertainty of the amount of gas which may leak from the pipe as compared with the practical certainty of knowledge concerning electric drop. In all of these conditions the copper wire appears to have the advantage of the gas pipe.

Mr. Perry is doing a good work in calling public attention to the merits of the gas engine as a substitute for the steam engine as a generator of electric power, and to the possibility of generating very cheap electric power from the piles of culm in the anthracite coal regions, but we think he will wait a long time before seeing any extensive adoption of his scheme for transmitting power by means of compressed gas instead of by electric wires.

LETTERS TO THE EDITOR.

Method of Laying Out Curves.—Correction.

Sir: I notice that in publishing my letter on "Quick Method of Laying Out Curves by Ordinates from a Long Chord," in your issue of April 29, an error was made in printing the formula for the side ordinate next to the end of the chord; it should read:

$$n = M - \frac{\left(\frac{c}{2} - s\right)^2}{2R}$$

Yours truly, W. B. Lee.

Hillburn, N. Y., May 1, 1897.

The Manner of Increasing Train Speed by the Holman Speeding Truck.

Sir: Your recent statements regarding the Holman Locomotive Speeding Truck Co.'s device afford very interesting reading both to engineers and intending stock purchasers, but in your editorial remarks in your issue of April 29 there is a statement which I do not follow. You say: "It is true that the Holman locomotive gives a higher train speed for a given piston speed," and then make the suggestion that this result may be attained in a far more sensible way. Why a certain piston speed giving a corresponding linear, and therefore train, speed to

the circumference of the drivers in the case of the simple locomotive should develop into something greater when the drivers of the simple locomotive are perched upon the wheels of the speeding truck with the circumferences all in rolling contact, is not clear to me. Any statement you may make explaining this will be appreciated.

Very truly,
W. C. Weeks, U. S. Assistant Engineer.

St. Paul, Minn., May 3, 1897.

(The manner in which the "speeding truck" acts to increase the train speed corresponding to a given piston speed was indicated by the diagram accompanying the editorial remarks to which our correspondent refers, as he will see by examining it more closely. Each wheel of the truck receives its power at one diameter of tread and imparts it at another and larger diameter. The tread of the locomotive driver bears on the smaller diameters of truck wheels d and e, in the diagram, the larger diameters of wheels d and e bear on the smaller diameters of wheels a, b and c, and the larger diameters of these last wheels bear on the rails.—Ed.)

Explosion in the Tunnel Under Lake Michigan.

Sir: In your comment (Engineering News, April 22) on my explanation of the accident in the Northeast lake tunnel of Chicago, you take exception to the method therein practiced of burning the gas in the heading, stating also that "it is the duty of an engineer in responsible charge of work to save his workmen from the dangers to which they themselves are oblivious." It is this very desire to prevent these dangerous conditions to which you allude that prompts the management to eliminate the risk of explosion by proceeding in the manner described. If it is a "rough and ready means of testing for gas," as you state, it is also true in this instance that it is a safe, effective, reliable, and the only practical one. Had you regarded my statement "that there was no accumulation of gas, nor could there have been under the circumstances," as a statement of fact, as you were warranted in doing, you could not have drawn the conclusion you did with reference to the danger involved.

Also, if there could have been no accumulation of gas, as I stated, with what appropriateness do you compare conditions existing in the tunnel with an explosion from escaping gas in the cellar of a dwelling house? The cellar will have no current of fresh air furnished by a fan; the tunnel is thoroughly ventilated all of the time by means of an 8-in. pipe, through which fresh air is fed continuously direct to the face of the tunnel. The person going into the cellar with a lighted candle is not expecting the presence of gas, while the test (and at the same time the remedy) in the tunnel is with a knowledge of conditions and the means at hand of preventing any personal injury, not of causing it. This gas, being lighter than the ordinary atmosphere of the tunnel, rises to its highest part over the miners' heads among the bracing timbers in the arch; and it is absolutely necessary to the prosecution of the work that this gas be eliminated in the manner as described, and at periods of frequency depending upon the strength of the vein encountered.

Your suggestion that "when the presence of combustible gas is suspected in a tunnel or mine * * * that the only proper test for it is the exploration of the suspected area with a safety lamp," would undoubtdly be the proper precaution to observe were the tunnel or mine of large area and of numerous chambers and headings; but in this particular instance it is of no virtue whatever; for there is but one heading of 13 ft. diameter as it is mined, and at no time with its face in excess of 20 ft. from the completed brick lining, which effectually excludes the gas from issuing from the fissures previously encountered.

Igniting the gas with a lighted candle upon the end of a 10-ft. pole, and permitting it to be consumed, as it is in a very few moments, removes the danger to the workmen, which you suggested was the duty of an engineer in responsible charge of the work. All responsible engineers will recognize the truthfulness of this statement at once and without argument; but to these engineers must be given the discretion of treating problems according to local conditions and according to the exigencies of each individual case as encountered, and not according to fixed rules and methods of procedure.

Very truly, Howard H. Jackman.

112 No. Humboldt St., Chicago, Ill., May 3, 1896.

(With the fuller description of the circumstances under which the work is carried on, which our correspondent now gives, we believe that he has established the safety of his method of work, and we therefore withdraw the criticism which we made upon it.—Ed.)

Resistance of Vehicles on Common Roads.

Sir: I think Engineering News once remarked "that nothing lied like an experiment when not honestly conducted." I regard the article, entitled "Tests of the Resistance of Vehicles on Common Roads," by the Office of Road Inquiry of the U. S. Dept. of Agriculture, as a clear and forcible demonstration of that theory as to lying. I understand from the article that the tractive force was a team of horses, and I doubt whether any team ever exerted anything approximating a uniform pull, for even a very short period of time, on any kind of a road.

The article says: "On the smoothest possible macadam road surface the force of traction changed continually within a range of 50 lbs. Considering the wonderful complex nature of a team and driver, the variation seems very small. Comparing the variations of force on a dirt road to that on the smoothest possible macadam road, the article says: "The force varied from absolute zero to 700 lbs." Here is a statement that would seem to need some explanation; what produced this "absolute zero?" If it was not the team and driver allowing the load to move by its own inertia, and if the team and driver are the cause of this absolute zero, why are they not the cause of the maximum force of 700 lbs.?

That the real force required to move a load on an ordinary dirt road is a rapid succession of violent jerks, is hard to believe. I do not think that the users of dirt roads will admit this theory of a rapid succession of violent jerks. Did any race-horse man ever dream of testing his horses' speed on anything but a dirt road? Many horsemen have refused to race their horses because even the dirt road was too hard.

In "Conclusions," drawn from tests and observations, the article says: "Starting a heavy load is equivalent to a violent blow." Now, as a matter of fact, with an intelligent team and driver starting a load is not a blow at all. The intelligent driver never draws his team "well back" and then urges it suddenly forward against the collar. About rigid traces, I think I may say that, ordinarily, there is no such thing as rigid traces.

Mr. Neely thinks there should be some elastic connection between the wagon and the team. In my judgment, the horse itself and the present ordinary connections furnish all the elasticity needed. The most elastic connection I have known between a team and its load is the long towing-line between the team and the canal boat, and yet I believe no horses suffer so much from bruised shoulders as boat horses, and here I may ask the readers of Engineering News to imagine a boat driver drawing his team well back and urging it suddenly forward against the collar in the hope of seeing it start the boat. Even the team knows a better trick. It walks slowly into the collar and then gradually increases the tension on that elastic connection until the load starts, which it will do if the boat is afloat.

It is written: "On a smooth road the force necessary to start a load was four times as great as the force required to draw the load at a uniformly slow pace when started." This result could not have been brought about, except by the "new horsemanship" practiced at Atlanta. This "new horsemanship" would appear to be able to show any result asked for. No doubt there are many readers of Engineering News who have seen around manufacturing establishments some powerful horse that was used instead of a switch-engine to move cars about the works. I think no one ever saw a heavy car started by urging the horse suddenly forward against the collar. The feat cannot be accomplished in any such manner. It appears to be a decided misnomer to call the result of urging the team suddenly forward against the collar the tractive force, as in such a manner it would be an easy matter to test the tractometer to destruction without starting the load.

There appears to be something entirely wrong with the tractometrical tests as conducted at Atlanta. The report says that in order to obtain results that would be accurate and of scientific value, a tractograph was devised to record the pull automatically. This tractograph showed the force required to draw a ton on a level dirt road to be 96 lbs., and on a 10% grade macadam road, 236 lbs. But Mr. Neely says that a team of small mules readily drew twelve bales of cotton weighing 500 lbs. each, upon a heavy Studebaker wagon up the 10% grade, and yet the driver refused to venture upon the dirt road with the same load, although, according to the data furnished, the pull would have been only 407 lbs. It might be of some scientific value to explain just why the driver refused to venture upon the dirt road, particularly as this team is shown to have been able to exert a pull of 1,900 lbs.

Coming from the Office of Road Inquiry of the Department of Agriculture, it is not unfair to presume that this information is furnished for the benefit of farmers. Just how the farmers are to be benefited by much of this so-called good-roads literature that is being furnished them, is a mystery. Much of the good-roads literature seems to come from the manufacturers of bicycles, rock-crushers, explosives, etc., etc., who are trying to increase the sale of their products. These people are continually presenting figures to show how much the farmer has lost during the interval between the time when we had nothing but water transportation in the world and the present, by not having roads macadamized. If these people would present some plain facts, instead of figures that are beyond the comprehension of the farmer or any one else, they would deserve some credit. I think it clear that on a large majority of country roads the condition of traffic is such that very little improvement is justified. It is known that the day of the heavy stage-coach and the long-distance freight-wagon has passed, and that the railways are gradually reducing the traffic on the public roads. The macadam road is not a real necessity to the farmer. He has always a surplus of horse-power and can do his hauling at a time when the dirt roads are in good condition, so that little or nothing is lost by the fact that the dirt roads are sometimes bad.

If the idea is to increase the maximum load, it is easily demonstrated that the macadamizing of the level or low grade divisions only of the ordinary country road is a failure. It is also easily demonstrated that a simple and efficient way to secure the maximum load is to macadamize the maximum grades or inclinations only. But if we take the data of the Office of Road Inquiry and consider also the fact that 10% is not the maximum grade of the ordinary country road, we will see that alone, even the best macadamizing will increase the maximum load only a trifle.

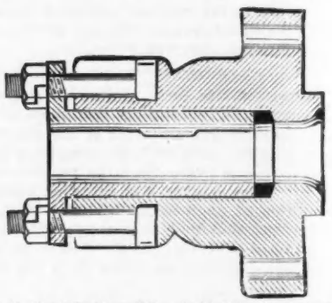
Charles Thorne.

Guatemala, C. A., April 24, 1897.

A NEW FRONT-HEAD FOR ROCK DRILLS.

This head is designed to facilitate packing and to minimize the cost of replacing worn parts. As shown in the illustration, the head is made up of a casing with a bearing sleeve inside, a packing ring, on which the inner end of the sleeve rests, and two bolts to secure the sleeve to the casing. The heads of these bolts enter outwardly, opening recesses in the front-head casting, and pass through lugs on the sleeve or bushing, and are fitted with elastic self-locking nuts.

The advantages claimed are as follows: The packing is at the upper end, where experience has shown the least wear to occur, and, as a consequence, the piston rod is always well packed. As the wear of this piston rod is mostly on a sleeve, running nearly the whole length of the head, there is no wear on the head itself; and the device is economical, since the sleeve can be replaced at a low cost as compared with the expense of replacing a worn front-head.



Longitudinal Section of Front-Head for Rock-drill with Removable Bushing.
Made by the McKiernan Drill Co., 126 Liberty St., New York City.

The construction also allows of re-packing by simply loosening the two nuts holding the sleeve and withdrawing the sleeve itself. This improvement has recently been patented by the McKiernan Drill Company, 126 Liberty St., New York city.

THE DEVELOPMENT OF COLORADO'S MINING INDUSTRY.

In a paper read at the Colorado meeting of the American Institute of Mining Engineers, Mr. T. A. Rickard, State Geologist of Colorado, traced out in a most interesting manner the history of mining development in that state. This history covers but one generation, dating back only 36 years; and while we cannot give the paper in full, some important events are here abstracted.

The discovery of gold in Colorado was made in 1849 by a small party of Georgians, who were taking a herd of horses across the continent to California. This party reached Camp Lyon, on the Arkansas River, in October, and by the advice of James Dempsy, a government guide, they established a winter camp at the junction of Cherry Creek and the Platte River. They there found gold on the banks of Cherry Creek, but the fear of Indians prevented them from penetrating into any of the mountain canons. Early in 1850 they crossed the mountains by the Badger Pass and went on to California, and nothing more was done towards finding gold in what was then Western Kansas until 1858. In this year a party of eleven California miners, including the original seven Georgians, again visited their old cabins on the Platte and found sufficient gold to encourage

them to organize prospecting parties. They found gold on Boulder Creek and at Russell's Gulch. By the close of 1858 rumors of rich placer diggings in this region had crossed the plains, and in 1859 the rush began to set in.

The Gregory lode was discovered on May 6, 1859, a date usually regarded as the real birthday of Colorado's mining industry. The tellurides of Gold Hill were not found until about 1872, but the recognition of the true character of these ores soon led to the exploitation of other rich mines. Silver ores were first discovered in 1859 in Gilpin county, and the silver mining industry of Upper Clear Creek grew to important proportions in the decade, 1860-70. The mines at the head of Virginia Canon date from the opening of the Specie Payment mine in 1876; and from the placers of Blue River and its tributaries $35,000,000 has been taken since 1859. In 1878 George Fryer sunk a hole on the hill north of Stray Horse Gulch and uncovered the famous carbonate ore; and a month later Rische and Hook found the ore body afterwards known as the Little Pittsburgh mine. Other discoveries soon followed, with the result that Leadville's output of $3,000,000 in 1878 swelled to $13,500,000 in 1887, and aggregates $215,000,000 to date.

By 1864 the easily amalgamated surface ores had been exhausted in many cases, giving place to hard pyritic material, which refused to yield up its contained gold. A resulting depression fell upon the district, which was not removed until 1868. In this year new discoveries were made, expenses were diminished by consolidation and the smelter came to the rescue of the baffled mill-man. The Boston & Colorado Smelting Co. was organized in 1867 by Prof. H. P. Hill, and the establishment was opened for business at Black Hawk in January, 1868. In 1870 the smelter removed to Denver, and in 1873 a refinery was erected, under Richard Pearce, and the shipment of matter to Swansea ceased.

The gold territory southward, in the mountains draining into the San Juan River, was discovered by Jim Baker in 1861, but work amounted to little until the ratification of the Brunot treaty in 1873, by which the Indians ceded this part of the territory. In 1871, however, lode-mining was commenced at the Little Giant, now the present town of Silverton, and in 1874 a smelter was erected, chiefly for the use of the Aspen mine.

Mr. Rickard then brings the record down to a later date. The history of the last decade, covering the stories of the growth of Aspen, Creede and Cripple Creek, the collapse of silver mining in 1893 and the later development of new gold fields. The development of Cripple Creek, at present the largest producer of gold of all the mining camps of the United States, followed the collapse of silver mining in 1893, and resulted from the fact that the men of Aspen and Leadville turned with the energy of despair to the exploiting of gold mines previously little thought of. With rare good fortune the camp responded with a swift succession of rich discoveries, and the gold output of Cripple Creek increased from $583,000 in 1892 to $2,100,000 in 1893, $3,900,000 in 1894 and $7,800,000 in 1895. To the present date, says Mr. Rickard, Colorado has yielded gold to the value of $137,475,000 and silver having a coinage value of $400,000,000. The new gold fields lie on the southern slope of Pike's Peak, the guide of the early pioneers and a mountain that gave its name to the mining excitement of the early 50's. Though no gold of any amount was found at that time, Pike's Peak has at last justified the expectations of the tenderfoot of 40 years ago.

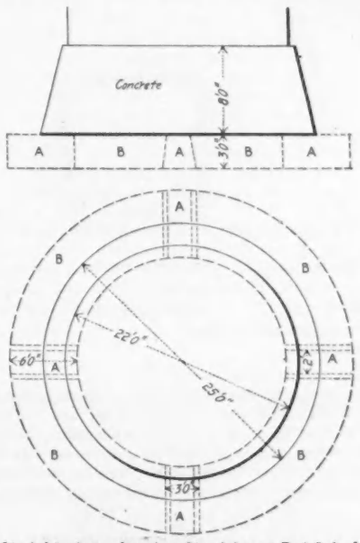
LEANING STAND-PIPES AT RED OAK AND GRISWOLD, IA.

By W. D. Lovell.

The Red Oak Case.—The stand-pipe for the water system at Red Oak, Ia., is 22×100 ft., and was built early in the season of 1895. The foundation consisted of a concrete pier 25 ft. in diameter at the base, about 22 ft. at the top, and 8 ft. deep. This foundation rests upon a clay soil, hard and uniform in character, of unknown depth, which when saturated with water becomes very soft.

In the erection of the stand-pipe an interior float was used, water being admitted from the mains. When the stand-pipe had reached the height of about 60 ft. it was thought that it leaned slightly to the northwest. At times during the erection it was necessary to let out considerable water for various causes, which was done by cutting out a few rivets. These rivets were always taken out on the north or northwest side, because the lay of the land was such that the water would tend to run away from the stand-pipe by so doing. Most of the excavation for the foundation was done with a scraper, and the cut for pulling out was on the north side, which cut of course was filled in when the foundation was complete, but this loose clay became saturated with water to such an extent that it was possible to push a lath down its entire length with very little energy, so that a body of water was constantly held on the north and northwest sides, which in time tended to soften the clay below. As is usually the case, water was escaping from the stand-pipe in more or less quantity during the entire time of erection.

The stand-pipe was completed and nearly filled with water, and the workmen had gathered up their tools and gone elsewhere, when one bright Sunday



Straightening a Leaning Standpipe at Red Oak, Ia. Crellin & Lovell, Engineers.

morning it was discovered that the structure was leaning perceptibly to the northwest. The water was immediately let out of the stand-pipe, which stopped further settlement.

Upon examination, it was found that the stand-pipe leaned to the northwest about 30 ins. at the top and that the foundation was uninjured. The cause of leaning was unequal settlement, due (1), to the fact that the stand-pipe was not situated symmetrically on the foundation, the center of the pipe being about 7½ ins. to the north and 3 ins. to the west of the center of the foundation; (2), that the clay load of about 2.6 tons per sq. ft., not including any wind pressure, was too great for the character of the soil; (3), that water in large quantities was allowed to escape on one side of the foundation and the conditions were such that the clay on the northwest became saturated, and when the tank was filled unequal settlement was a natural result.

To straighten the stand-pipe, an excavation 3 ft. wide to the depth of the foundation was made entirely around it. Then four concrete piers, 6 ft. long, projecting 3 ft. under the old foundation, were put in. These piers were 3 ft. wide on the bottom, 2 ft. wide on top and 3 ft. deep. After these piers were in place, the soil under the old foundation was bored out and the monolithic foundation allowed to settle down on the piers, from which the stand-pipe was easily gotten back into a vertical position. Then a rubble masonry footing, 3 ft. deep, extending for 3 ft. under the old foundation, was put in between the piers. The whole seems to be in first class condition now, and shows no signs of unequal settlement. The straightening was done under the direction of Crellin & Lovell, of Des Moines.

The Griswold Case.—The foundation is of concrete, about 7 ft. deep. On the east side there is built a concrete manhole extending to a distance of 6 ft. from the stand-pipe, which vault was solidly attached to the main foundation and is virtually a part of it. The stand-pipe was completed and stood apparently vertical before being filled. It was observed during high winds that the foundation as a whole had a perceptible motion and that the top of the pipe at such times swayed at least 6 ins.

Within a few hours after being filled with water, the pipe began to settle to the northwest to a visible degree. Cracks opened between the foundation and the ground on the east side, and the clay was correspondingly compressed on the west side. The tank was emptied as soon as possible, but the top had leaned over at least 13 ins.

On examination it was found that the material on which the foundation rests was very soft yellow clay, apparently uniform in character on all sides of the foundation, and at least 14 ft. deep. The stand-pipe was not concentric with the foundation. The load per sq. ft. of foundation, namely, 3,600 lbs., was more than this character of soil would carry, and the manhole projection on the east side acted as foundation, so unequally loading the clay.

Nothing has been done to straighten up this stand-pipe, and contrary to the expectations of many it has been filled several times and still stands. The city officials contemplate putting four guy wires to it. No further settlement has taken place.

One thing of interest, however, is apparent, namely, that when the stand-pipe is about half full, the top leans out about 12 or 13 ins., and when full, 16 ins. Some observers conclude that the weight of the water in the top of the pipe causes the pipe itself to spring 3 or 4 ins.

CAR LIGHTING BY ELECTRICITY.

The application of the electric light to railway cars possesses many advantages from the points of view of both passengers and railway officers, but the cost of operation has in most cases prevented the general adoption of such a system of lighting. We have from time to time described the various systems experimented with or used in regular service in this and other countries, and the most promising direction for the design of a car lighting system which will be both efficient and economical appears to be in making each car independent and using a combination of dynamo (driven from one of the car axles) and storage batteries.

This combination is effected in the system owned by the American Railway Electric Light Co., which has been applied to the Pullman car "Mabel" running in regular service on the Pennsylvania R. R., and which has already made a total of 3,668 miles. This car has 28 incandescent lamps of 16 candle-power, 60 volts, requiring 28 amperes. The 2½-HP. motor is clamped to one of the car axles by a split sleeve, and is suspended from the truck frame by a heavy spring which takes up the vibration. The armature is geared direct to the axle, no belting being used. The motor is connected with a 32-cell 250-ampere Syracuse storage battery in which is stored the surplus energy to supply the current when the car is not in motion. At speeds below 20 miles per hour the armature revolves without generating any current, but as soon as the car reaches this speed an automatic switch throws the generator into action. Another automatic device is applied by which only 25 amperes of current are generated when the lamps are not in use, and 40 amperes when the lamps are in use. The dynamo is protected by a casing and the bearings have automatic lubricators. No attendant is required on the car, the brakeman switching the light on and off as required.

This same car was formerly equipped with a somewhat similar system by the same company, and ran about 20,000 miles, when the motor burned out. The new equipment is simpler and more effective.

A special trip of the car was made last week to exhibit the working of the new equipment. The system is owned by the American Railway Electric Light Co., 14 Stone St., New York city, of which Mr. Wilbur Huntington is President and General Manager, and Mr. J. L. Watson is Secretary.

SEWER OUTLETS AT NIAGARA FALLS, ONT.

By Chas. H. Mitchell, Town Engineer.

The sewerage works now under construction at Niagara Falls, Canada, present several novel features which are worthy of description. The system generally differs little from modern sewer construction, but the outlets through which the sewage is discharged are peculiar and have received considerable attention.

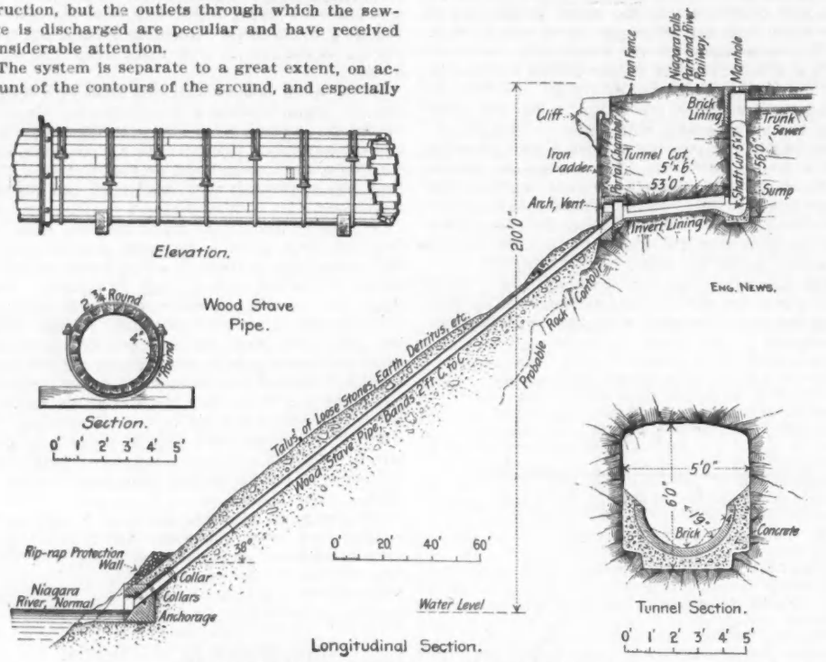
The system is separate to a great extent, on account of the contours of the ground, and especially as a creek flows through the chief portion of the city, toward which for many blocks there is a distinct fall, thus permitting of the ready disposal of surface water. The lower quarter-mile of this water course is covered in by a substantial stone culvert, 6×7 ft., and the city is now continuing this work up to a point such that danger from flood and overflow is minimized. Besides this, the present sewer construction provides for a relief overflow during time of freshet by an inlet at a point further up the creek into a trunk sewer, which here changes from an 18-in. pipe to a 36×48-in. egg-shaped brick conduit. This trunk sewer continues with the latter section for a half mile, where it empties into the river gorge immediately south of the cantilever bridge. There are two other drainage areas, the upper outlet being near the upper suspension bridge and another midway between the two.

The system when completed will embrace ten miles of sewers, of which at this date nearly half has been completed, including two of the outlets. In the construction, a large amount of rock is encountered, especially in those portions near the river. This rock is a limestone, not difficult to work, and has been taken out of sewer trenches during the past year at a price of about $2.20 per cu. yd.

The 38×48-in. brick trunk sewer previously mentioned consists of two rings of brickwork, the inner being complete, while the outer ring was replaced in the bottom by a hollow invert tile. The intention of this was to get the advantages of the invert block for foundation and drainage, and at the same time obviate the disadvantages which are usual with a construction wherein the invert block itself forms the invert of the sewer. There were nine special bricks, forming the lower portion of the invert, burned specially hard, while in the whole there were about 150 bricks per ft. This sewer cost about $4.50 per lin. ft., figured on an all-earth basis, the average cut to grade line being 11.2 ft.

The outlet works demanded entirely original designs, it being necessary to get sewage from the surface, over the cliff and down to the water's edge of the Niagara River, a fall of over 200 ft. The accompanying illustrations and the following description apply generally to the three outlets, the distances and dimensions of course varying somewhat with circumstances.

At points in the river road, which skirts the Canadian bank of the river, vertical shafts 5×7 ft., as shown in the longitudinal section, are sunk to a depth equal to the height of the cliff. These are lined at the top by 12-in. brick walls, backed by concrete, and supported by four-course arches set in the rock. The trunk sewers and such other drains as were necessary are securely built into this lining, also iron steps and platforms for purposes of inspection. The covering consists of I-beams and buckle plates, filled in with concrete and macadam pavement, a cast iron manhole top and cover of standard design being set in on one side of the same. The main parts of the shafts are unlined, but at the bottom are solid constructions of paving brick set in concrete backing, with such curves as to form a sump and water cushion from 2 to 3 ft. deep, as the case demands. On the river side of each shaft is a heavy brick wall, with an arch to hold the overhanging rock wall.



DETAILS OF OUTLET SEWERS AT NIAGARA FALLS, ONT.
Chas. H. Mitchell, Town Engineer.

From the base of the cliff a tunnel 5×6 ft. in section was driven to the bottom of each shaft, and on a grade of 10%. This was lined on the bottom, only, by an invert consisting of one ring of paving brick laid as stretchers and set in concrete, as shown in the cross-section. In the case of the two smaller trunk sewers, a smaller invert is formed by concrete. At the portal of each tunnel a chamber is built, having in front a heavy stone retaining wall, 4½ ft. thick at the toe, and built into the rock face of the cliff so as to securely support the hanging wall. The interior part is built of brick, backed with concrete, and has steps and supports for a platform. An arch opening, 3½×4 ft., is made in the retaining wall to afford ventilation, means of overflow, and access to the interior. This is covered by a grating on the river side. For purposes of inspection, an iron ladder is built down the cliff at each outlet.

One of the most novel features of these outlets is the means of getting down the slope or talus of the river gorge. The materials composing the slope have assumed an angle of repose of about 38°. From examinations which have been made at places in the gorge, it appears that the solid rock shows some such profile as is indicated, and that the regular slope is formed over this, consisting of loose stones, detritus and earth. Percolating through this loose material is a considerable amount of water, arising from springs in the cliffs and rocks, all of which is impregnated with lime. In view of these difficulties, the design of a substantial and economical conduit down the talus demanded careful attention. Masonry, either brick or stone, was out of the question, unless it were possible to excavate through the loose slope to the stable rock foundation beneath, a work of uncertain and very costly extent. Cast iron pipes of a sufficiently large size were not considered practicable, on account of their weight and inflexibility in an unstable ground, they being very liable to part at the joints. Riveted plate pipe would, it was considered, be quickly attacked by the quantities of lime water coming through the slope, and would very soon become disjointed and collapse. The design as now constructed is of wood stave pipe, built of first quality pine, of staves 4 ins. thick, the whole banded every 2 ft. with round iron, as shown in the illustration.

In two of the outlets the interior size of this pipe is 2 ft. (the sewers being 18-in. pipe and 24×36-in brick) and in the third, 3 ft. (the sewer here being 36×48-in. brick). Theoretically these outlet pipes are larger than required, but experience with other small pipes down these slopes has shown that gorging frequently occurs, and when such is the

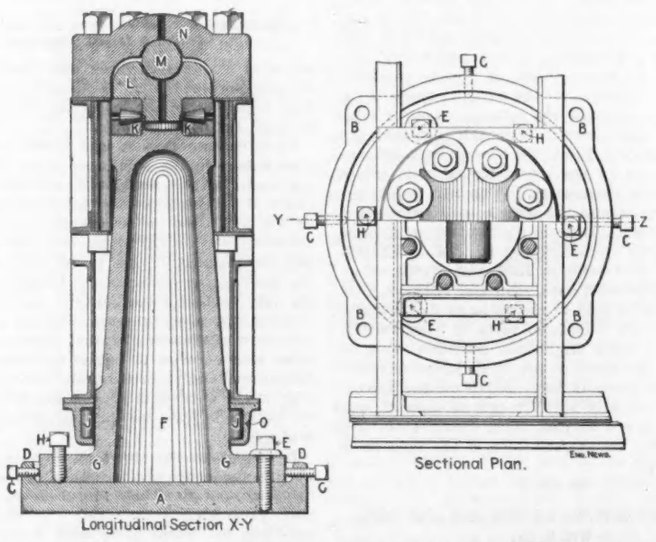


FIG. 1. ADJUSTABLE CENTER PIVOT FOR GREENLEAF RIVETED STEEL TURNTABLE.

case the matter is serious under such velocity. It is claimed for this design that the pipe is very strong, is comparatively light, is durable, being preserved rather than attacked by the water and moisture, is flexible throughout, and is perfectly smooth, offering but little resistance to the passage of water. The wearing action of the sewage is reduced to a minimum in these outlets on account of the extreme angle of the grade and the fact that the system, being separate, carries but little sand or silt, and that only occasionally.

In the construction it was necessary to excavate from the top of the talus downward and construct the pipe from the bottom. A firm foundation for the anchorage at the water's edge was obtained upon a bed of boulders in shale and gravel. The anchorage consists in each case of 70 cu. yds. of stone masonry, and the pipe is firmly embedded in the main portion and anchored by two cast-iron collars. Another collar is placed above each anchorage at a distance of 14 ft. and supported by posts from the face of the masonry. A water cushion 4 ft. deep was obtained at the foot of the pipe.

The lengths of the staves in the pipe varied from 14 to 16 ft., and they were cut to a width of 5½ ins. on the outside face. The staves were painted on all surfaces with two coats of carbolineum, and joints were made in white lead, end joints being secured by a steel tongue. The staves were lowered over the cliff and built into the work singly, as the pipe could not be built in sections. The inclination at which the work required to be carried on rendered it doubly difficult, especially in the unstable material. The mud sills, 10 ft. apart, were first set to grade, the bottom section laid thereon, and templets placed, when the upper staves were put in place, the last ones requiring to be driven home beneath the loosened bands. When the staves in a section were all in, they were driven to their true position from the interior and the bands tightened, after which the back filling was proceeded with, from the bottom upward.

The two outlets now built under this design have cost about $3,600 each. The sewerage system has been carried out under the direction of the writer as chief engineer.

THE GREENLEAF CENTER-BEARING TURNTABLE.

A turntable operated by compressed air is the latest novelty presented by the Greenleaf Turntable Co., of Indianapolis, Ind., in the way of locomotive turntable construction. At present this company is making three classes of tables, as follows: (1), a 60-ft., 100-ton turntable of gun metal, composed of three parts of old car wheels and two parts of Pine Grove pig iron; (2), a 110-ton to 150-ton capacity riveted steel turntable, and (3), a 150-ton to 200-ton capacity turntable, 65 ft. long, made of cast steel. In Engineering News of Sept. 10, 1896, the full girder details of a riveted steel table, a strain sheet for the cast steel table and the center bearing and platform construction for the gun metal table were illustrated. In this issue the description of the Greenleaf turntable is continued with illustrations of the center bearings for the riveted steel and cast steel tables, and also details of the platform construction of the cast steel table.

The peculiarity of the Greenleaf turntable is that it is entirely a center bearing table, the center pivot being the only support which the table has in turning, no end wheels being used. Its designer is Mr. C. A. Greenleaf, of Indianapolis, Ind. Fig. 1 shows clearly the adjustable center pivot for the riveted steel type. It is well known that in erecting a turntable it is very difficult and sometimes almost impossible to get the center foundation exactly in place. Even when such a location is secured the foundation is subject to slight movement from settlement before the drainage has been perfected and the masonry reached its permanent seat on the foundation bed. Accidents also frequently cause changes in level or alignement. If the pivot casting is made adjustable so that such changes in the foundation can be corrected in the pivot alone, obviously an advantage in maintenance and perfectness of operation is secured, and this adjustability is provided in the pivot illustrated.

Turning to Fig. 1 it will be seen that the foundation plate A is fastened to the foundation masonry by means of four 1¾ in. bolts passing through the holes B, B, &c. This foundation plate is furnished with four adjusting screws, C, C, etc., threaded into the projecting rim D, and also three holes threaded for the holding down bolts E, E, etc. Otherwise the foundation plate is a plain gun metal casting 4½ ins. thick, with no other finishing. The center post F has a flange G through which are bored six holes. Three alternate holes are threaded for the screw bolts, H, H, etc., and the other three holes are smooth bore, 2½ ins. in diameter for the holding down bolts E, E, etc., which are provided with washers 4½ ins. in diameter and ⅞ in. thick. The center post is finished on the roller path J near the base and at the top where the conical roller housing K is fitted and doweled.

After the foundation plate A is bolted fast to the foundation and about level, the center post F is placed and adjusted to an exact perpendicular by leveling the finished top with an ordinary spirit level. It is then adjusted to the exact center of the pit. The leveling is done by the screw bolts H and the centering by the adjusting screws C. When all adjustments are completed the holding down bolts E are screwed down so as to fasten securely the center-post to the foundation plate, and then melted sulphur is poured into all spaces between the center-post and foundation plate. The platform after this can be erected upon a perfectly adjusted center bearing.

Being without end wheels, it is evident that the construction of the center bearing must be such as to hold the table true to center and to preserve its adjustment both horizontally and vertically. The center-post F carries the conical roller ring housing and rollers of Crescent crucible steel, upon which rests the cap L, provided at its top with a cylindrical recess for the roller M. The yoke N rests on the cylindrical roller M, and carries by means of bolts the housing O and the arms to which the table girders are hung. Inclosed in the circular housing are the vertical cylindrical rollers J bearing against the finished track on the surface of the center-post F. It will be noticed that the roller M is placed with its axis at right angles to the center line of the table, and also that the cylindrical recess holding the roller is of slightly larger diameter than the roller itself. When, therefore, the table tips to receive the locomotive, or under unequal loading, the roller M travels slightly toward the end which has the preponderance of load. At the same time the vertical rollers J undergo a slight vertical movement. The tendency of roller M is, of course, to return to its normal position as soon as possible; first, because it is resting on an inclined surface, and second, because the closely fitting train of vertical rollers J is exerting a pull upon it. As soon, therefore, as the locomotive is fully balanced upon the table, it becomes horizontal, as it also does through its own weight when unloaded.

The theory of operation of the center pivot being explained, it only remains to note some of the minor features. With the exception of the vertical roller housing, which is of cast steel, and other special parts already noted, all center castings are of gun metal and all bolts of machinery steel. The total weight of the center is 6,000 lbs., and its cost at Indianapolis, Ind., is $300.

Turning now to the platform and center-bearing

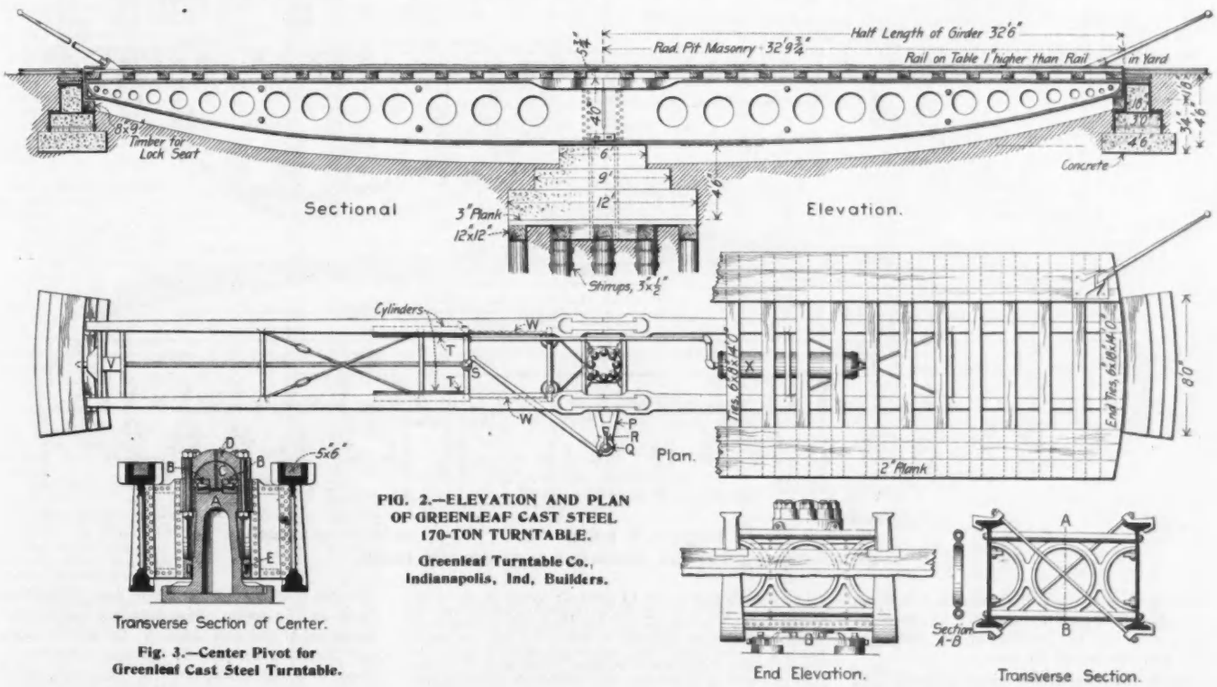


FIG. 2.—ELEVATION AND PLAN OF GREENLEAF CAST STEEL 170-TON TURNTABLE.

Greenleaf Turntable Co., Indianapolis, Ind, Builders.

Fig. 3.—Center Pivot for Greenleaf Cast Steel Turntable.

construction for the cast steel table, Figs. 2 and 3 must be consulted. This table was designed for a safe load of 170 tons, and with the exception of the center pivot and operating mechanism, which will be described later, is fully explained by Fig. 2. The material is basic steel, having a tensile strength of from 60,000 lbs. to 70,000 lbs. per sq. in., and the following chemical composition: Carbon, 16% to 20%; manganese, 60% to 80%; sulphur, trace to .05%; phosphorus, trace to .025%. The forgings are made of crucible machinery steel, and all joints of both forgings and castings are machined to a full bearing. The girders were cast by the American Steel Foundry Co., of St. Louis, Mo.

Since writing the above and preparing our engravings the designer, Mr. C. A. Greenleaf, has informed us that the distance from the top of the the sediment or grit that may be in the oil in the pocket formed by the lower housing and the top of the pedestal, and flushing out any dust that may have settled in the outer rim of roller bearing. The hemisphere is 16 ins. in diameter, and is provided on its lower side with a projecting hub, or dowel, 5½ ins. in diameter and 3½ ins. long. This hemisphere is machined on its lower side and on the dowel, so as to fit the housing. The dowel passes down through the upper housing and into the eye of lower housing, to within ¾-in. of the pedestal. Its top side is convex and is finished hard, and is ¼-in. smaller in diameter than the concave recess in the cap that surmounts it. This forms the differential ball and socket, balancing joint.

The pedestal is machined at its top and is also provided with a dowel on its top 5½ ins. in diameter by 1 in. high. The top of the pedestal and the dowel are machined so that the lower housing has a true and solid bearing on the pedestal and cannot be moved from the center. It becomes practically a part of the pedestal. The cap has an average thickness of 5 ins. and is securely bolted to the center box by eight steel bolts 3½ ins. in diameter. The bolts are set up to greater tension than is required to sustain the load so that in regular service they cannot be brought into unequal tension. This cap is machined nected at top by the 5½ ins. in diameter dowel, and with all revolving bearings provided with anti-friction rolls. The dowel on the hemisphere takes the shock received from the engine passing on or off the turntable, and communicates it all to the pedestal.

The pneumatic turning machinery mentioned in the first paragraph, as applied to the cast steel table, is shown in Fig. 3. The bracket P is bolted to the side of the table, and carries the vertical standard Q, which is operated by the lever R, placed within reach of the cab window. Turning the lever operates a valve S, which has receiving and exhaust openings for each pipe, one to each hoist T and one to each end of a Knowles valve at cylinder V. From the pistons of the hoists T pipes W pass around the center post of the pivot as a drum, and are wound and unwound to turn the table by the travel of the pistons. Cylinder V is

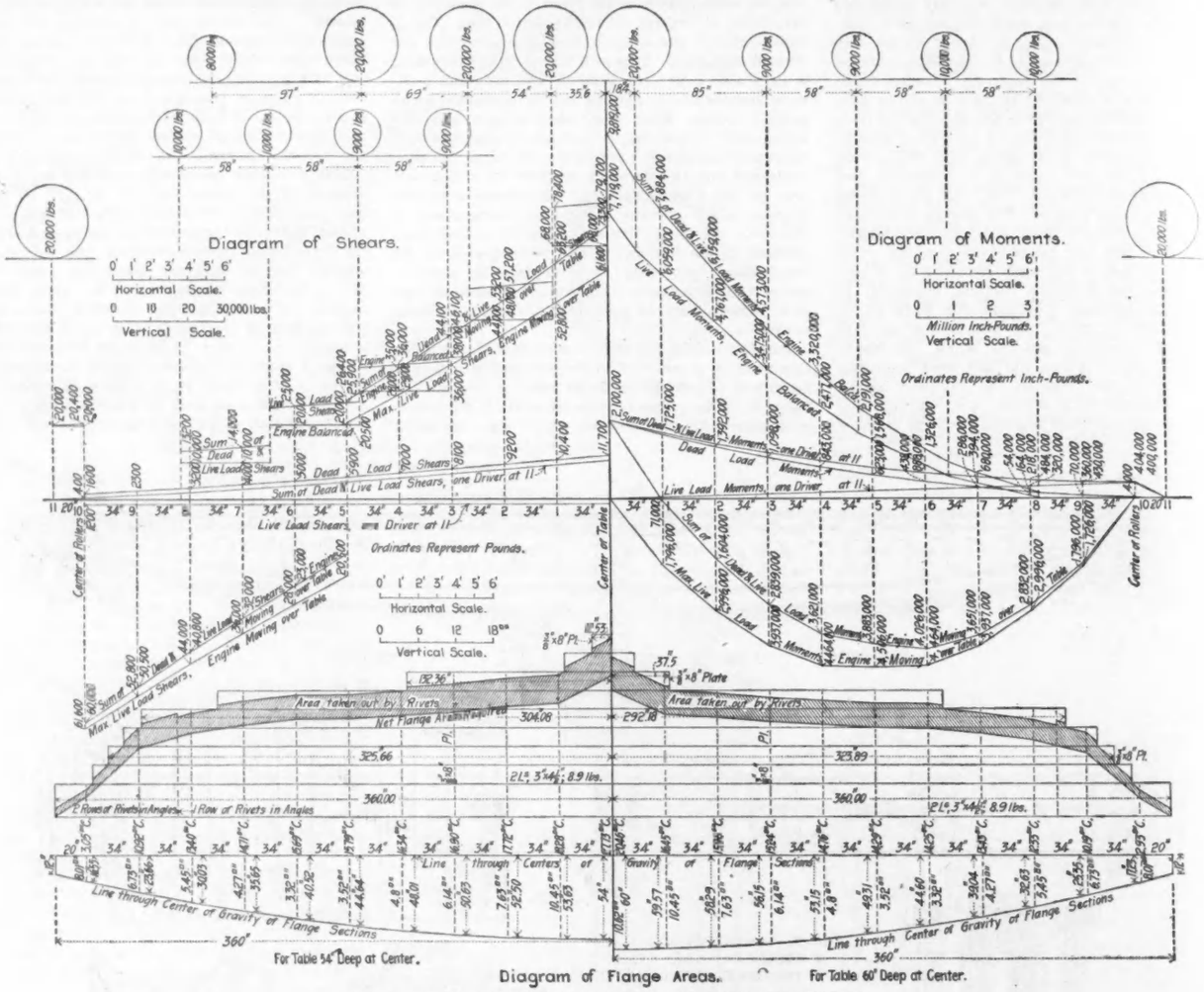


FIG. 4.—STRAIN SHEET FOR GREENLEAF CAST IRON TURNTABLE.

center stone to base of the rail should be 4 ft. 9 ins. instead of 4 ft. 6 ins., and the distance between the top of the girder and the bottom of the cross ties should be 6 ins. instead of 5¾ ins.

Fig. 3 shows the dust-proof roller bearing that sustains the whole vertical load. It is made of cast steel and consists of the pedestal A, the conical rollers and housings B, the hemispherical bearing C, the cap and yoke D, and the vertical roller bearing E. The bearing is described as follows in a letter received from the designer:

The 16 conical rolls interposed between the two housings are 2 7-16 ins. diameter at large end, 1 1-16 ins. in diameter at the small end and 3½ ins. long. They roll free, without axles, in an annular groove that is machined to perfect bearing in each housing, deep enough to keep the plane sides of housings ¾-in. apart for wear. The lower housing is provided with two lips that project upward, so that they form of the lower housing an oil cup that does not overflow until the lower side of the upper housing is touched by the oil. The oil is poured in at the top of the cap, first reaches the top of the pedestal, then rises and flows from the center outwards, leaving on both faces and it can be adjusted to the center of the platform by the four adjusting screws shown at the top of the center box, before the cap bolts are tightened up. When all has been adjusted as above the cap and center box act as one piece. The center box is 26 × 26 ins. by 1¾ ins. thick, and has a vertical depth of 3 ft. 7 ins. It is provided with four vertical flanges on which to rivet the cross struts that connect the center to the platform. It is machined on the top for cap bearing, and has a bearing for the vertical rolls machined and 24 ins. in diameter and 4 9-16 ins. wide. The rolls are 2 7-16 ins. in diameter by 4½ ins. long. They are fitted as tight as they can be into place between the groove in the center box and the roller path on the pedestal, being driven in with a hand hammer, through an opening that is left inside of center box after the center is erected. This bearing in combination with the differential ball and socket balancing joint at the top is what balances the turntable always to a horizontal, when the table is released from the preponderance on either end. If this arrangement is carefully considered it will become apparent that the circular track is superfluous.

In addition to the balancing to a horizontal this arrangement insures that the table can only revolve to center, and can be displaced or capsized only by some extraordinary force sufficient to break the posts. The center post piercing the turntable platform through, from bottom to top, is a substantial and close fitting journal bearing which is 19 ins. in diameter near base, firmly con- for the purpose of latching and unlatching the table at the ends. The drawing shows the construction of the end latches. To supply air to the cylinders a reservoir X, holding sufficient air for from 10 to 15 revolutions of the table, is located as shown. This reservoir is filled from time to time by means of the locomotive air brake pump. It will be seen that by this mechanism the table can be turned, stopped and locked by the engine driver alone without leaving the foot board of his engine. This pneumatic apparatus costs $200.

Regarding the foundation and pit construction, no detailed description is necessary, as these differ on different railways. The particular point to be noted is that no circular track foundation, coping and rail are necessary. The various other structural features not described are shown by the drawings, for which we are indebted to Mr. C. A. Greenleaf, Indianapolis, Ind., the designer of the various turn tables mentioned.

AN INDEX TO THE REPORTS OF TESTS ON THE EMERY TESTING MACHINE AT WATERTOWN ARSENAL.

The reports of tests conducted on the Emery testing machine at the Watertown Arsenal form probably the most valuable records of the strength of materials to be found in this or any other language. The 15 volumes of these reports are to be found, we believe, in the libraries of most engineering schools and engineering societies; and any such institution which does not possess them should lose no time in securing them.

The lack of a general index to these volumes, however, is quite a hindrance to their profitable use, where an engineer desires to search for records of tests on a particular subject. To obviate this Prof. J. B. Johnson, of Washington University, St. Louis, Mo., has recently compiled a general index to these volumes and by his courtesy we are enabled to present it to our readers.

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Cables	'89	472-474
Cables	'90	662
Cables	'91	720-722
Cables	'92	587-594
Cable, shackles and swivels	'93	303-308
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Cable, chain iron, shackles, swivels	'94	253-258
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Cylinders for crusher gages	'93	267-281
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Cotton cloth	'85	1127-1128
Ducking	'87	995
Cloth	'90	1150
Cloth	'93	531
Cloth for targets	'94	639
Cubic compression, metals and wood, Part II	'86	1661-1688
Material used: Mild steel, wrought iron, drawn brass, drawn copper, Banca tin, lead, Silesian zinc, white pine and white oak. Tabulated results on page 1687.		
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Steel shafts rotating	'89	619-634
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Wrought iron	'90	959-1049
Cast iron	'90	1050-1054
Steel shafts	'90	1055-1096
Cast-iron shaft	'91	671
Cold rolled iron bar	'91	672-675
Steel bar	'91	676-678
Tension tests of fractured ends	'91	679-719
Rotating shafts	'92	521-548
Steel shafts	'92	521-533
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Steel hoops shrunk on steel tubes	'86	1182-1192
Steel hoops shrunk on steel tubes	'87	792-801
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And hemp cordage	'91	747-787
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Mill columns	'88	727-729
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Chain cable	'89	472-474
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Railway axles	'92	465-472
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A GOVERNMENT ARMOR PLANT would cost at least $3,000,000, according to the estimates of Secretary of the Navy Long submitted to the Senate Naval Committee. This is double the estmate of the late Secretary Herbert, which was $1,500,000. Secretary Long also recommends that the limit of cost per ton of armor plate be raised from $300 to $400, and says that it would be impracticable and undesirable for the government to now enter into the manufacture of armor. The alternative of a refusal of the makers to furnish armor at $400 per ton is the use of laminated armor on the new battleships Nos. 7, 8 and 9. This latter armor, though inferior to the solid plate, is easier and cheaper to make and can be purchased within the $300 limit from other steel manufacturers and without excessive delay.

A TEST OF DOUBLE VS. SINGLE ARMOR PLATE was lately made at Indian Head for the purpose of ascertaining whether the thinner plates, which can be furnished by several manufacturing concerns outside of the great armor makers, would answer the same purpose, when superimposed, as the heavier plate. In the test a 6 and a 5½-in. plate were joined by clamps, so as to practically make 11½ ins. of solid steel. These plates were then subjected to the impact of a 10-in. projectile having an initial velocity of 1,950 ft. per sec., sufficient to penetrate 12 ins. of solid steel. One shot only was fired. Both plates were pierced and the projectile went 30 ft. beyond the rear backing, practically uninjured, the point only being somewhat distorted. Armor experts differ somewhat as to the conclusions to be drawn from the experiment, and the tests are to be continued.

A RECENT IMPROVEMENT IN BLAST FURNACE practice, which is rapidly being adopted in large furnaces, is the increase in the number of tuyeres. Mr. S. W. Vaughen, furnace manager of the Cambria Iron Co., Johnstown, Pa., recently put 16 tuyeres in the No. 6 furnace of that company. This is about double the number that it has hitherto been customary to use in large furnaces. An interesting statement in this connection appears in the "Iron Age," of May 6, to the effect that as early as 1862 Mr. Samuel Thomas, of the Thomas Iron Co., Hokendauqua, used 21 tuyeres, each 8×1½ ins., in the No. 3 and No. 4 furnaces of that company, making the tuyeres practically continuous. Furnace No. 3 was in blast from July 18, 1862, to June 29, 1863, or 49 weeks, and on being blown out was found in excellent condition. The furnace was started up again with its 21 tuyeres on Aug. 22, 1863, and was kept in blast until April 9, 1867. The main trouble encountered with the tuyeres was that since they were not protected by water jackets they suffered from a tendency to undermining, so that their noses kept dipping down. To counteract this a plate was put on top of the back of the tuyeres. This is believed to be the first instance on record of the plan of making the tuyeres zone practically one belt.

THE WASTE OF NATURAL GAS in the Alexandria oil field of Indiana is being complained of, and delegations of manufacturers are presenting petitions to the Governor, asking that he take means to prevent it. It is stated that millions of cubic feet of gas are being daily wasted by oil prospectors in the attempt to get at the oil beneath. The point is made that while the oil would only benefit the producers, the gas would benefit the general public, and its waste should be stopped by legislation. The Governor has already instructed State Gas Supervisor Leach to investigate the reports and to stop violations of existing law.

A HEAT TRANSFORMING ELECTRIC BATTERY claimed to have been invented by Mr. H. V. Essick, of Yonkers, N. Y., is commented on unfavorably by the "Electrician," of London. A Daniell cell surmounts a stove, which heats the electrolyte, and its specific conductivity is thereby increased. The "Electrician" points out that the temperature needed to bring the electromotive force of a Daniell cell up to 2 volts, from its normal value of 1.07 to 1.09, is about 12,000° C., at which temperature, it says, most mundane material, including the hard cash of investors, would be dissipated.

A NEW SIGNALING APPARATUS, called the "Telephotos," has been invented by M. C. V. Boughton, of Buffalo, N. Y. It consists of a number of electric lights, arranged so that any combination, either in the same or different colors, can be instantly lit or put out by the manipulation of a simple key-board. This apparatus, placed on some high point, can flash an easily read cipher to distant points. The machine was successfully tested by Forecaster Cuthbertson, and was so evidently successful that one will be placed on the Guaranty Building and will be used to notify the Lake mariners of the weather changes.

A SYSTEM OF ELECTRIC TRACTION, in which the third rail supplying the current is covered over so as to be protected from snow and sleet and not liable to be touched by persons crossing the line, has been brought out by the Krotz, Allen & Kelly Co., of Springfield, O. The conductor is an inverted angle iron, supported by wooden posts on the ends of the ties, these posts being boiled in oil to make them act as insulators. Over the rail is an inclined wooden cover, with a vertical board at the back to cover in the rail. The contact shoe carried by the car bears on the inner and under surfaces of the angle iron. Mr. A. S. Krotz is the engineer of the company.

THE ELECTRIC MOTORS for the motor cars of the Chicago & South Side Elevated Ry. (Alley Line), which are to replace the present steam locomotives, will be furnished by Frank J. Sprague, of New York city. The contract includes furnishing the motors and fitting them upon the cars. This change is necessary to enable the road to use the downtown loop in conjunction with the other elevated railways, but the road has the right to operate its trains by steam on this loop for about two years.

THE USE OF ELECTRICITY ON STEAM RAILWAY lines is being extended by the New York, New Haven & Hartford R. R. Co. On May 10 a trial trip was made between Berlin and Hartford with a motor car weighing 32 tons and carrying 70 passengers. Current was furnished from a power house in Berlin and was transmitted along the line by a third rail. The train was run on regular schedule and between two trains drawn by steam locomotives. The 13 miles were covered in 18 minutes.

A CABLE INCLINE RAILWAY is being built up the slope of the Devil's Dyke, near Brighton, England. It will be 840 ft. long, with a total change in elevation of 295 ft. There is a grade of 1 in 2.9 at the bottom, then one of 1 in 1.5, with a grade of 1 in 1.8 for 240 ft. at the top. The grades are connected by vertical curves of 1,000 ft. radius. The line is double track, 3-ft. gage, with 35-lb. T rails laid on longitudinal timbers, which rest on 6×6-in. piles driven into the chalk formation. Transverse timbers at intervals of 15 ft. hold the ballast in place, and the gage of the longitudinal timbers is maintained by transverse tie-rods and sleeves. There will be two cars, one on each track, connected by two of Lang's steel wire cables, 2 ins. circumference. The cable has a speed of 260 ft. per minute, and the driving drums are operated by gearing by a Hornsby-Akroyd oil engine of 25-HP. at 180 revolutions per minute. The cars are open, seating 14 persons each, and each car has four steel grips which take hold of the rails in the event of the hauling rope becoming slack by breakage, or any other cause. The line is being built by the Pyramidical Syndicate, of London, and Mr. Charles O. Blaber, of Brighton, is the engineer.

THE VICTORIA TUBULAR BRIDGE over the St. Lawrence, at Montreal, is to be rebuilt, the tubular spans being replaced by truss spans, and the piers being lengthened to support a wider superstructure. Mr. Joseph Hobson, Chief Engineer of the Grand Trunk Ry., informs us that the weight of the superstructure will be approximately 19,000 tons, and that a joint contract for the work has been awarded to the Detroit Bridge & Iron Works Co., of Detroit, Mich., and the Dominion Bridge Co., of Montreal.

THE ABOLITION OF GRADE CROSSINGS is to be carried out at Dedham and Hyde Park, Mass., by the New England R. R. and the New York, New Haven & Hartford R. R. The railways will be elevated, but in some places the streets will be carried over the tracks.

A TUNNEL UNDER THE HARBOR at Oakland, Cal., is proposed by the authorities of Oakland and Alameda as a substitute for the two existing bridges, which are reported as obstructions to navigation. The tunnel would be for street cars, wagons and pedestrians, and the cost is estimated at $200,000 by Mr. Lyman Bridges, Engineer to the Oakland Board of Trade.

THE BIDS FOR 12-IN. MORTARS lately called for by the Ordnance Department, developed the fact that the U. S. Arsenal at Watervliet was among the lowest bidders and obtains the contract for finishing and assembling 36 out of 63 mortars. The Bethlehem Iron Works will furnish the forgings, and the last of these is to be delivered at Watervliet early in 1898.

LOW BIDS FOR CITY WORK have just been made in two cities. At Erie, Pa., the lowest of five bids for 4 to 12-in. cast-iron pipe was $16.35, submitted by the Lake Shore Foundry, of Cleveland. At Marietta, O., three bids on 1,475 sq. yds. of brick paving were 57, 60 and 62 cts. per sq. yd., the lowest bidder being a local contractor and the other two outside men.

A PAPER MAKING MACHINE, said to be the largest in the world, has been built by the Rice, Barton & Fales Co., Worcester, Mass., for the Rumford Falls Paper Co., Rumford, Me. It will be shipped in a few weeks. The total length of the machine is 175 ft. and its width 26 ft. It will deliver a web of newspaper 150 ins. wide at the rate of 500 ft. per minute. As the paper is delivered it will be cut into the widths desired. The paper company has already four machines, by the same builders, one of which will turn out paper 135 ins. wide. In the new machine the largest of the rollers weighs five tons. It has 32 steam dryers, each 48 ins. diameter.

A PNEUMATIC ATTACHMENT TO A PLANING MACHINE, which operates the feed mechanism, and also a clutch, which takes the place of the commonly used belt shifter for reversing the motion of the table, has been patented by Mr. Alex. Gordon, President of the Niles Tool Works, Hamilton, O., and is used by that company on several of its large planers. It is illustrated in the "Iron Age" of April 29. A small cylinder operated by compressed air has its valve opened by the tappet on the planer table, throwing the piston which is at one end of the cylinder to the opposite end. The piston rod extends through both ends of the cylinder. One end has a rack attached which operates the feed mechanism, and the other transmits force through a lever and rock shaft and a worm gear and rack to a rod which moves the central member of a reversing clutch from one pulley to the other, by means of which the motion of the table is reversed.